September-October 1994

PROGRAM MANAGER

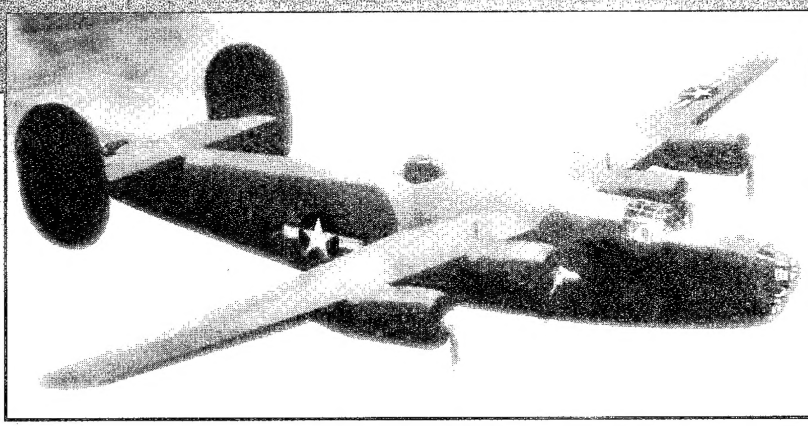
Journal of the Defense Systems Management College

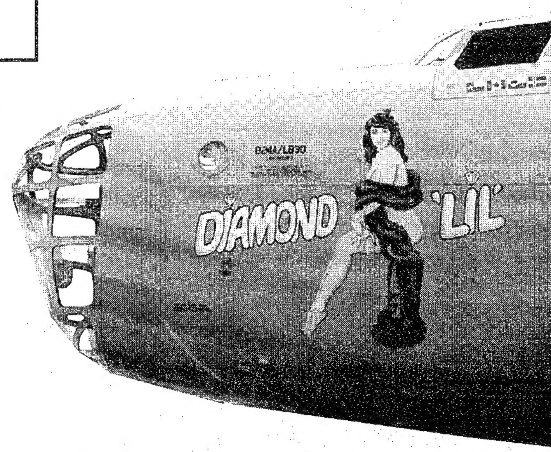
Better Management with Fewer People

A Guide to the Color of Money

Physics of Failure

Liberators, Mustangs and "Enola Gay"





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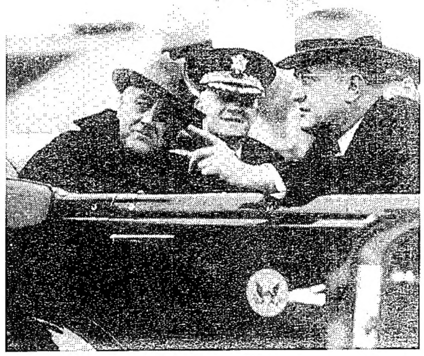

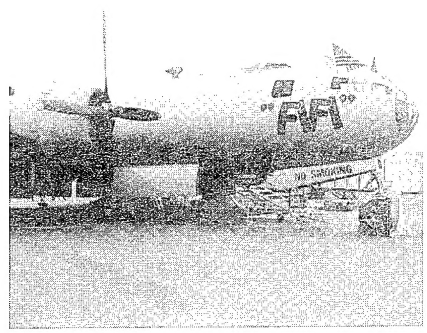

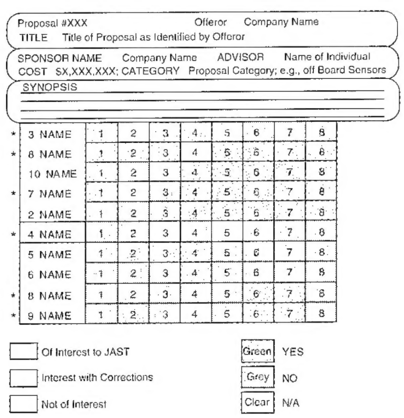

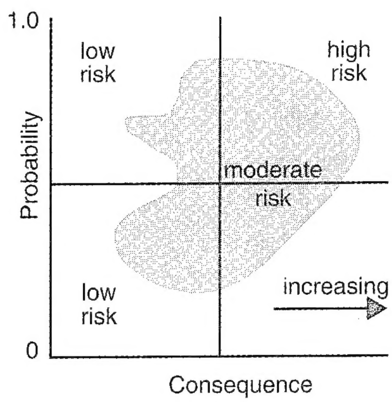

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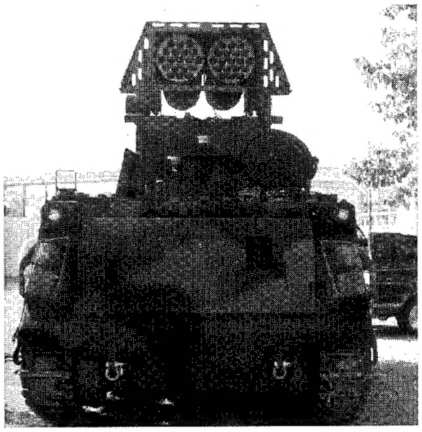
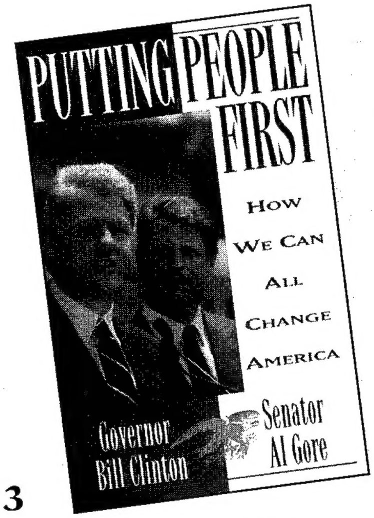
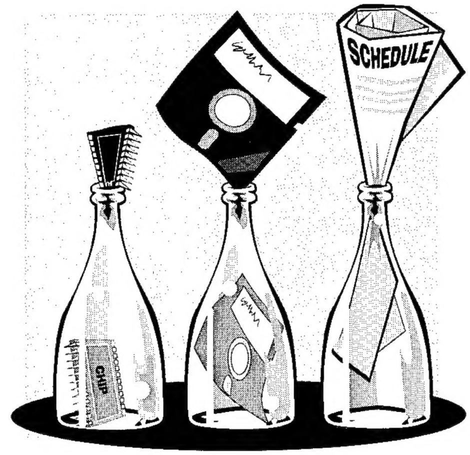
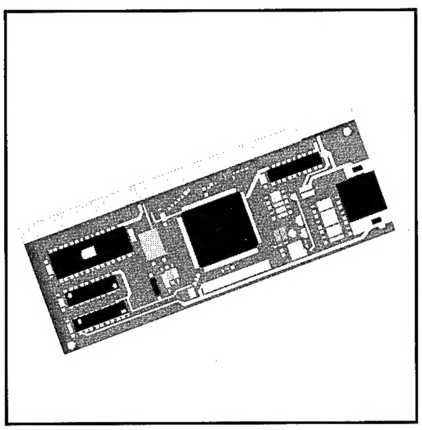
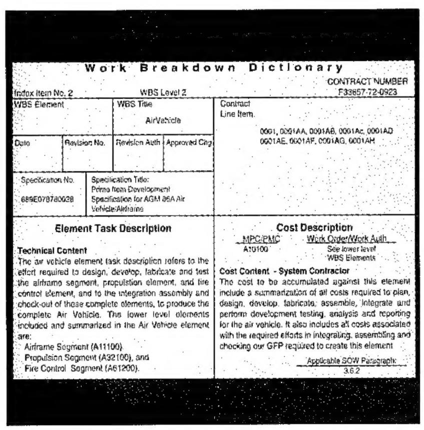
COVER: On overlay of cockpit of "Fifi," Boeing B-29 Superfortress of the Confederate Air Force (CAF), are shown the Consolidated B-24 Liberator bomber in flight during World War II (WWII), and the CAF's "Diamond Lil," a restored WWII B-24.











Work Breakdown Dictionary

Index Item No. 2 — WBS Level 2 — CONTRACT NUMBER F33657-72-0923

WBS Element	WBS Title	Contract Line Item.
	AirVehicle	0001, 0001AA, 0001AB, 0001Ac, 0001AD 0001AE, 0001AF, 0001AG, 0001AH

Date	Revision No.	Revision Auth	Approved Chg

Specification No.	Specification Title:
689E078780028	Prime Item Development Specification for AGM 86A Air Vehicle/Airframe

Element Task Description

Technical Content
The air vehicle element task description refers to the effort required to design, develop, fabricate and test the airframe segment, propulsion element, and fire control element, and to the integration assembly and check-out of these complete elements, to produce the complete Air Vehicle. The lower level elements included and summarized in the Air Vehicle element are:
Airframe Segment (A11100),
Propulsion Segment (A32100), and
Fire Control Segment (A61200).

Cost Description

MPC/PMC	Work Order/Work Auth
A10100	See lower level WBS Elements

Cost Content - System Contractor
The cost to be accumulated against this element include a summarization of all costs required to plan, design, develop, fabricate, assemble, integrate and perform development testing, analysis and reporting for the air vehicle. It also includes all costs associated with the required efforts in integrating, assembling and checking our GFP required to create this element

Applicable SOW Paragraph: 3.6.2

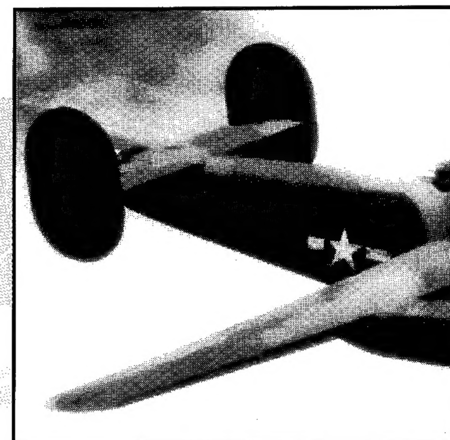
Also

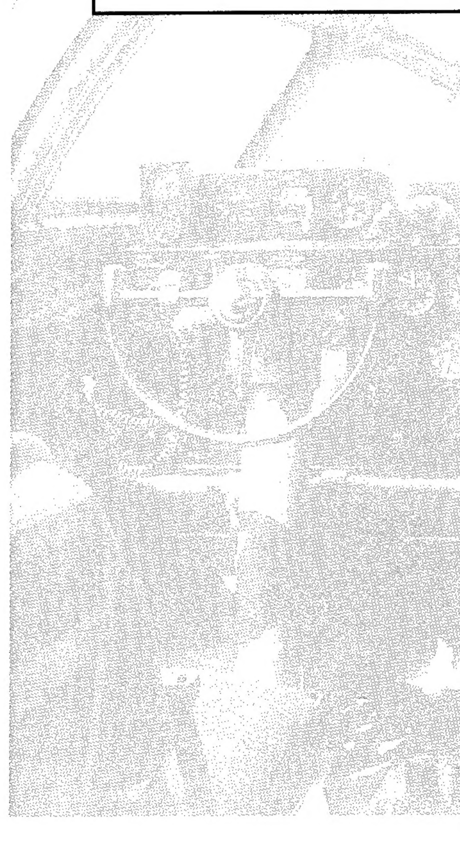
A MASSIVE BUILDUP

LIBERATORS, MUSTANGS AND "ENOLA GAY"

America Acquires Army Air Power for World War II

Cadet J. Jeremy Marsh, USAF


B-24 photo courtesy U.S. Air Force



Being unusually frank, in January 1939, the Chief of the General Headquarters of the Army Air Corps, General Frank M. Andrews, labeled his Air Corps "fifth or sixth rate." Extremely inferior to European air forces, Andrews said that the United States had only slightly more than 400 first-line combat planes, most of which were approaching obsolescence, compared to a German combat air force estimated between 4,000 and 10,000. By beginning to build up the U. S. air force, he continued, we were "saying in unmistakable language, 'Hands off the Western Hemisphere— America is for Americans.'"[1] If ever, now was the time.

Indeed, the massive buildup of American air power that took place from 1940-45 transmitted this message in terms no one could mistake. By the end of World War II (WWII), the status of not only American air power, but of global air power as a whole with its potential affect on both war and peace, had changed drastically.

As we commemorate the 50th anniversary of WWII, in which the Army Air Forces (AAF) played a decisive role in contributing to the Allied victory, *Program Manager* discusses how American science, industry and a dynamic acquisition process were harnessed to unleash the world's most powerful air force.

The Airmen Arrive: From Air Corps to Air Force

To understand how the United States acquired such an air force, one must review the evolution of the AAF role within the War Department. In 1939, the Army had almost total control over its air arm, labeled the Army Air Corps. The War Department retained some residual control.

When Henry L. Stimson became Secretary of War in June 1940, he took steps with Army Chief of Staff General George C. Marshall to increase the role of Army airmen. Seeing the need for someone who could act as a "Secretary of the Air Force," Stimson appointed Robert A. Lovett as Assistant Secretary of War for Air,

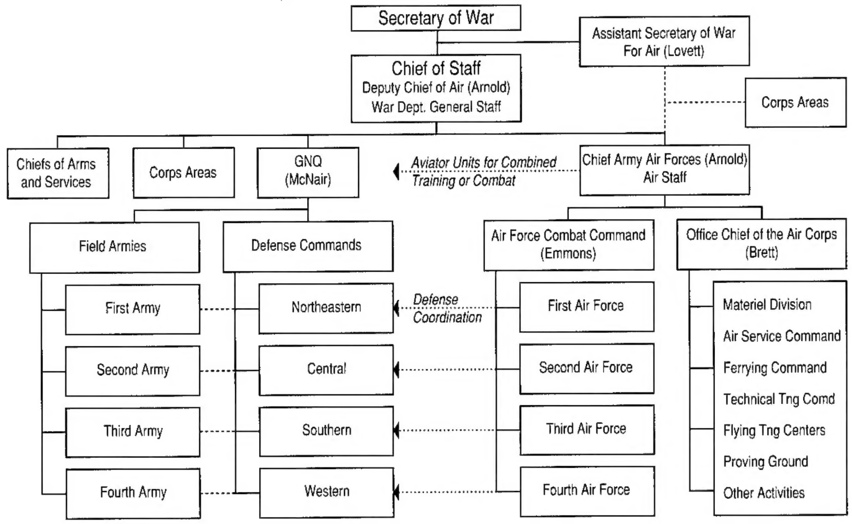
---

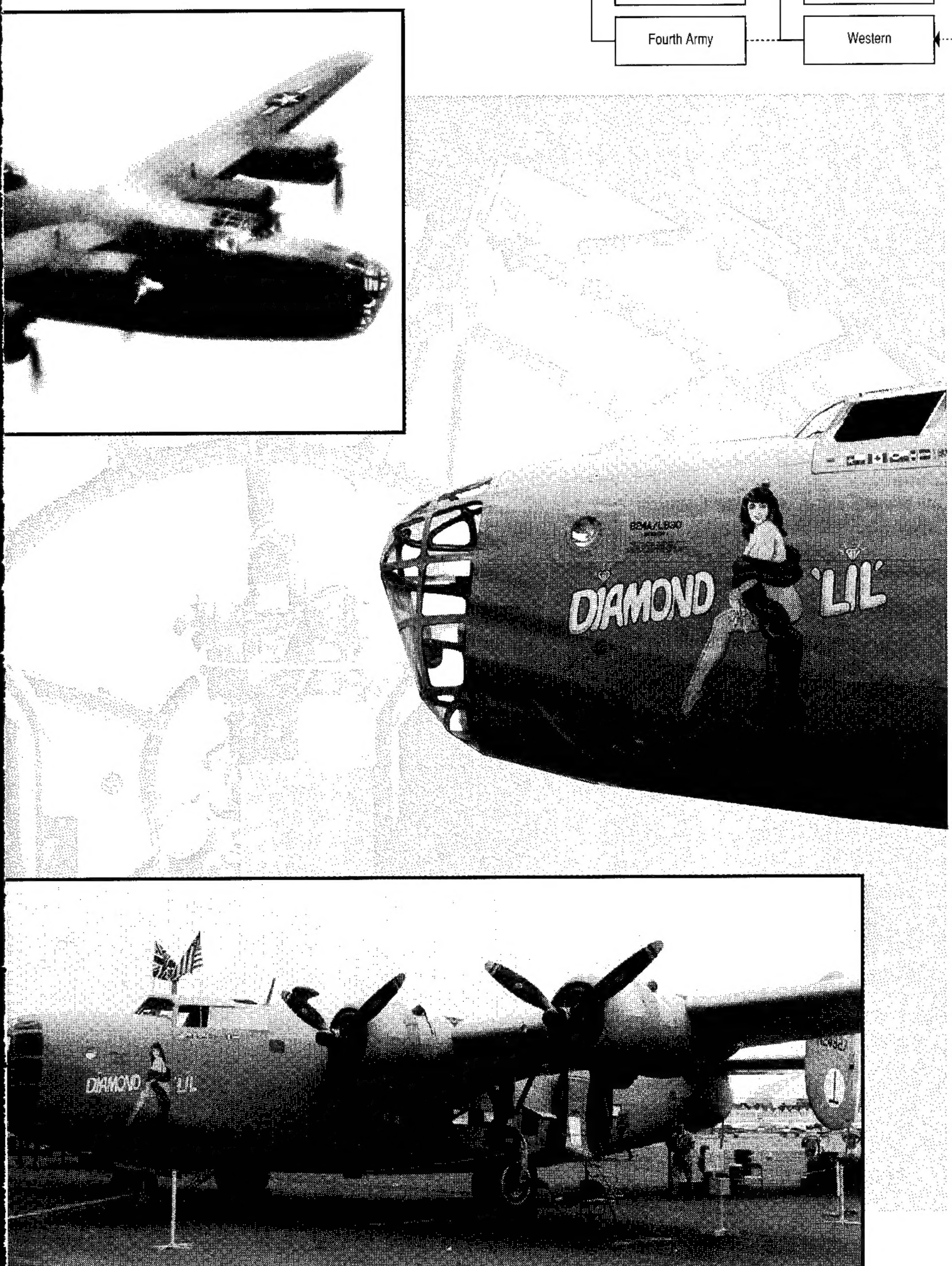
Cadet First Class Marsh is a senior at the U. S. Air Force Academy, majoring in history. He spent his Research Summer in 1994 working in the Research, Consulting and Information Division, Defense Systems Management College, on a special arrangement with the Academy, researching and writing this piece for Program Manager. *It will be included in the book being written by Wilbur D. Jones, Jr., of DSMC on the history of U. S. weapons acquisition.*

a position responsible for Air Corps procurement, organization and public relations. Soon afterwards, General Henry H. "Hap" Arnold, one of the Army's first pilots and, like Marshall, a West Point graduate, became Acting Deputy Chief of Staff for Air.

Despite these changes, airmen still lacked what they believed to be the three essentials for organizational success: a separate air staff, a unified air arm, and an air force coequal with

FIGURE 1. AAF in Army Organization — Late 1941





"Fifi" and "Diamond Lil" photos by Wilbur D. Jones, Jr.

ground and service forces. Not until a year later, 20 June 1941, did the Army establish the AAF from the old Air Corps, giving airmen two of their desired essentials: an air staff and a single commanding general (Arnold). Finally, on 9 March 1942, the War Department was divided into three separate coordinate forces for ground, air and services. Thereafter, the AAF functioned on a level basically equivalent to that of the Army and Navy, and remained so until 1947, when the National Security Act established the U.S. Air Force as a separate branch of the military.

Building an Air Arm, 1939-40

> *Air power is not a commodity that can be procured in the open market, no matter how much gold and silver may be available. Money will not buy it, desire will not create it. Timely foresight, based upon an intelligent conception of the potentialities of air power and its effect upon the destiny of nations, is the only formula that can assure its development.*[2]
>
> ***— General Frank M. Andrews, 16 January 1939***

On overlay of cockpit of "Fifi," Boeing B-29 Superfortress of the Confederate Air Force (CAF), are shown the Consolidated B-24 Liberator bomber in flight during World War II (WWII), and the CAF's "Diamond Lil," a restored WWII B-24.

*TABLE 1. Army Air Forces: Procurement Deliveries of Airplanes, January 1940 - December 1945***

Item	Quantity
Airplanes — Totals, all Types	231,099
Very heavy bombers — Total	3,899
B-l9 (Delivered in 1941)	1
B-29, Superfortress	3,898
Heavybombers — Total	31,000
B-17, Flying Fortress	12,692
B-24, Liberator	18,190
B-32, Dominator	118
Medium bombers — Total	16,070
B-25, Mitchell	9.816
B-26, Marauder	5.157
Other models	1,097
Light bombers — Total	18,113
A-20, Havoc	7, 385
A-24, Dauntless	615
A-25, Helldiver	900
A-26, Invader	2,450
A-28 & A-29, Hudson	2,189
A-30, Baltimore	1,575
A-31 & A-35, Vengence	1,931
A-36 (P-51 type), Mustang	500
Other models	568
Fighters — Total	68,712
P-38, Lightning	9,536
P-39, Airacobra	9,588
P-40, Warhawk	13,738
P-47, Thunderbolt	15,683
P-51, Mustang	14,686
P-59, Airacomet (jet propelled)	66
P-61, Black Widow	702
P-63, Kingcobra	3,292
P-70, night fighter type of A-20	60
P-80, Shooting Star (jet propelled)	243
Other models	1,118
Reconnaissance — Total	1,117
F-2 (version of C-45)	55
F-4 & F-5, (version of P-38)	500
F-6 (version of P-51)	299
Other models	263
Transports—Total	22 885
C-43, Traveller	352
C-45, Expeditor	1,771
C-46, Commando	3,180
C-47, Skytrain	10,368
C-54, Skymaster	1,162
C-60, Lodestar	620
C-61, Fowarder	1,009
C-64, Norseman	756
C-69, Constellation	15
C-78 (AT-17 type), Bobcat	3,206
C-87, Liberator Express	291
Other models	155
Trainers — Total	55,712
AT-6, Texan	15,094
AT-7, AT-10 & AT-11, Navigator (AT-7)	5,775
AT-8 & AT-17, Bobcat	2,153
BT-13 & BT-15, Valiant	11,537
PT-13, PT-17 & PT-27, Kaydet	7,539
PT-l9, PT-23 & PT-26, Cornell	7,802
Other models	5,812
Communications—Total	13,591
L-l, Vigilant	324
L-2, Grasshopper type	1,940
L-3, Grasshopper type	1,439
L-4 & L-14, Grasshopper type	5,611
L-5, Sentinel	3,590
R-4 & R-5 (helicopter)	161
R-6 (helicopter)	224
Other models	302

** Data represent factory acceptances or receipt of legal title by resident factory representative of procuring agency. Includes all airplanes procured by the AAF regardless of subsequent distribution to Army, Navy, recipients of Lend-Lease, or others. These airplane deliveries represent approximately 83 percent of all Army Air Forces procurement.
Source: *United States Army in World War II: The War Department; The Army and Economic Mobilization.*

Andrews and his fellow airmen had a long way to go in their quest to develop a true U.S. air power. Prior to 1939, the Air Corps, like other branches of service, suffered from the neglect that typically characterizes our nation's attitude toward the armed forces after a war. Planes were lacking both quantitatively and qualitatively, and the acquisition process was decentralized and unorganized.

However, as autumn 1939 drew near, and war in Europe appeared certain, President Franklin D. Roosevelt saw the requirement for expanding the armed forces, especially the air arm.* On 12 January 1939, the President pleaded to Congress that $300 million be allotted for a minimum increase of 3,000 planes. He asked that orders be placed on such a large scale to reduce their cost and enable the procurement of even more. By April, Congress authorized the Secretary to "equip and maintain the Air Corps with not to exceed 6,000 serviceable airplanes...together with spare parts, equipment, supplies, and hangars."[3]

When Nazi Germany invaded Poland on 1 September 1939 and launched WWII, the Air Corps had barely commenced expanding. Its strength was approximately 25,000 men and 800 first-line planes, compared to the German Luftwaffe's 500,000 men and 4,000 planes, and 100,000 men and 2,000 planes of the British Royal Air Force. An American historian said, "It would require several years of expansion and development before the United States could regard itself as a peer among the air powers of the world."[4]

In fact, in 1939, most of the planes with which the United States would fight in WWII had not even been developed. The saviors of American air power simply were time (the passage of world events) and geography (the protection of two oceans), which permitted America the space to execute the necessary air expansion. Without it, an Allied victory would have been much more difficult and lengthy to achieve.

Manufacturing in the Immediate Pre-War Period

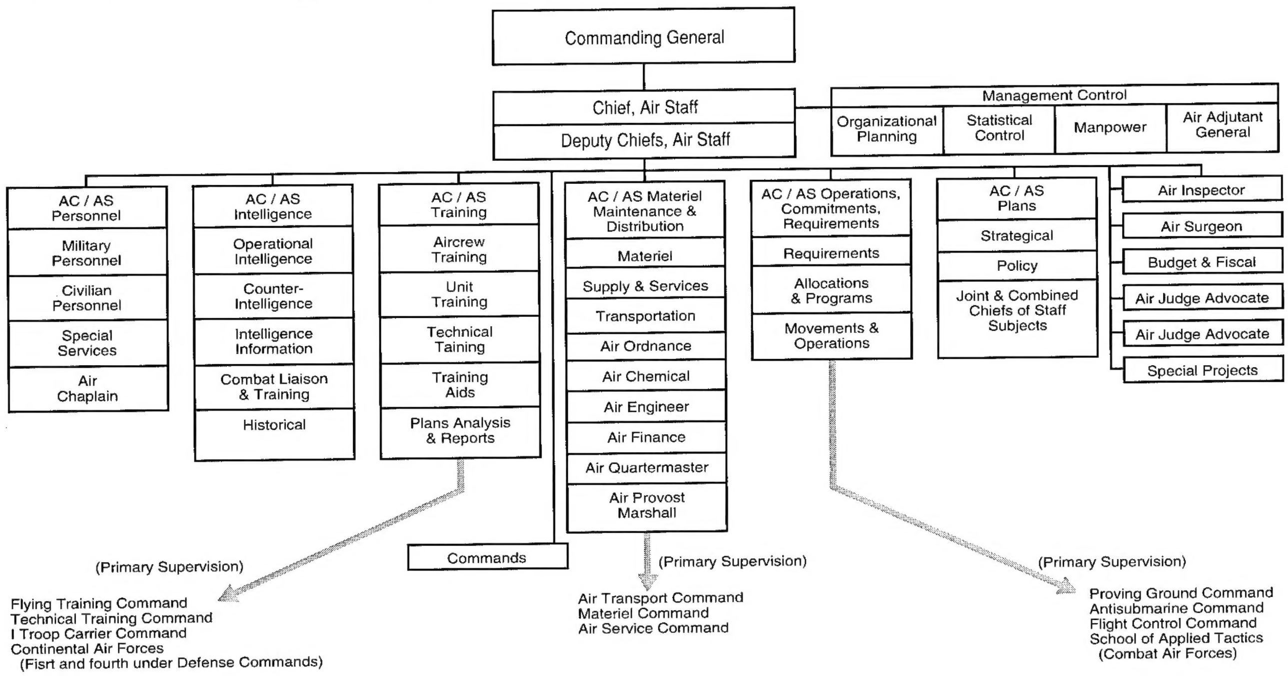
The expansion of the aircraft industry during WWII was the most dramatic development of the period. Large shipbuilding operations were not new; mass production of ordnance items was well established; but the manufacture of airplanes in production quantities had never been attempted in the United States.[5]

— S.A. Zimmerman, historian

Because it was a fairly new development, aircraft manufacture presented unique difficulties to procurement and production planning bodies in 1939 and 1940. Since World War I (WWI), industry had been hand-to-mouth in which every military air-

* Reference to the term "air arm" is only to the Army Air Forces, which constituted the majority of U.S. air power in WWII, and does not include Navy and Marine Corps aviation.

FIGURE 2. AAF Organizataion — March 1943



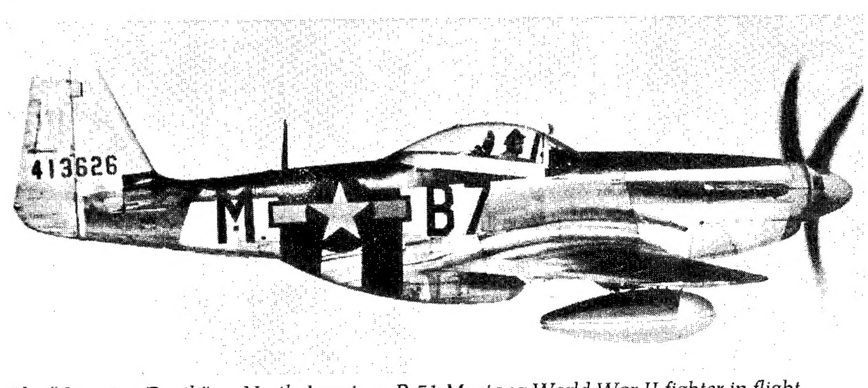
plane was custom tailored. Military leaders applied no pressure on designers to think up an airplane that they could mass produce in an emergency. One solution to the problem of mass production was to freeze standard aircraft designs.

In 1940, automobile manufacturer Henry Ford believed he could produce 1,000 aircraft per day as long as the "frozen" design was not interfered with by "men who haven't kept up to date in airplane design and operation."[6] The notion that designs could be frozen was unrealistic, as World War I (WWI) experience showed.

In WWI, a group of "experts" (progressive businessmen and engineers) were able to convince the public and, more importantly, Congress of the need to mass produce aircraft. These experts believed that aircraft manufacturers could carry out aircraft production in the same manner that Ford's plants carried out car production and by so doing create an air force. However, "Fordism" was not a success because its system was too inflexible for making wood, wire and fabric flying machines. In addition, the rapid rate of technological advancement made it impossible to mass produce a state-of-the-art plane, a difficult task even today.*

In July 1939, Arnold initiated a meeting of 18 industry heads and asked them two questions: First, was the capacity of the aircraft industry sufficient to "absorb the load...of the Expansion Program, and at the same time take care of the Navy load, plus the commercial load and any other load that may be put upon it by foreign orders?"[7] Second, what steps were necessary to expand the industry to meet the emergency wartime requirements that might be placed on it? Though the meeting produced good discussion, few tangible outcomes ensued. Industry had little incentive to standardize its mass-production methods or to expand its capabilities.

In 1939, aircraft companies were averse to expansion because a war boom was still unpredictable. With the Great Depression still fresh in their minds, they hesitated to invest in plants which they might have to dump into a post-war downturn. Too, in 1940, the European theater stag-



Courtesy U.S. Air Force

The "Creeping Death" — North American P-51 Mustang World War II fighter in flight.

* For more information on WWI aircraft acquisition, see Wilbur D. Jones, Jr., "Spruce, Dope and Fordism: The Flying Coffins; America Acquires an Air Arm, Wright Brothers Through the Great War," *Program Manager*, July-August 1993.

nated into the "Phony War" when both the Germans and the allies played "wait-and-see." The overriding question was whether the Americans would join the allies or remain neutral.

Four options for expansion were available to industry: government factories, an increase in plant capacity, more subcontracting to smaller aircraft firms and organizations outside of the aircraft industry, or conversion of certain industries such as the automotive one. In light of such uncertainty, industrialists favored the second option, provided the government would cover expenses associated with expansion: If the government wanted military airplanes, it must accept some of the risks.

Despite its attitude, in 1939 the industry was in the best condition of its short life. It employed 50,000 people, which was more than ever before; it ranked 41st among American industries with an output of almost $280 million; and by 1944, it would transform into the country's largest industry in business and earnings volume. Where in 1940 the aircraft industry produced some 13,000 aircraft, less than half military, in 1944 alone it turned out 96,000 military planes. Furthermore, industry's overall production in the 62 months between July 1940 and August 1945, during which time floorspace increased twelvefold and manpower sixteenfold, was 300,000 military planes at a cost of more than $45 billion.

Two factors in 1939 encouraged industry to begin expansion: persistence by the Air Corps, and foreign orders. To meet an annual requirement for 40,000 aircraft, the Army estimated that industry and government would have to construct 20 new factories, each capable of producing 1,200 planes. Foreign military orders, growing out of a desperate attempt by Britain and France to offset Luftwaffe superiority, provided the greatest stimulus. Virtually all leading airframe manufacturers (Lockheed, Glenn L. Martin, Wright Aeronautical, Boeing, North American and Douglas) and engine manufacturers (Pratt and Whitney and Wright Aeronautical) increased their floor space because of British and French orders.


Courtesy Air Force Academy Archives

President Franklin D. Roosevelt, left, visits Bolling AFB, Washington, D.C., prior to World War II, accompanied by General Henry H. Arnold and Assistant Secretary of War Louis Johnson.

Foreign orders were intensifying in 1938. However, because of America's security interests, foreign countries had to accept less than the best as the latest models were withheld. Once the war began, invocation of the Neutrality Act penalized the victims of aggression who had formerly bought arms from America. Roosevelt convinced Congress on 4 November 1939 to lift the arms embargo and allow foreign countries to continue purchasing arms on a "cash and carry" basis. The government also decided to release some of its newer models to the Britsih and French, including the B-18A and the P-40, and later the B-17, B-24, P-38 and P-51. With this new release policy, contracts skyrocketed.

In July 1940, after France fell, Britain alone had 8,275 planes and 21,485 engines on order. As 1940 closed, and the gravity in Europe became clearer, Roosevelt proclaimed the United States as the "arsenal of democracy" by offering complete service to the British. On 11 March 1941, the new Lend-Lease program authorized the transfer of weapons and equipment to countries whose defense was considered vital to the defense of the United States, which later included Russia.

Aircraft industries were receptive to orders from abroad because they made larger profits than from Army contracts. Yet, Army leaders knew that foreign competition would willingly pay for necessary plant expansion so manufacturers could meet their needs. Thus, American productive capacity was paid for largely by Britain and France.

50,000 Planes a Year

> *Air power has decided the fate of nations; Germany, with her powerful air armadas, has vanquished one people after another. On the ground, large armies had been mobilized to resist her, but each time it was additional power in the air that decided the fate of each individual nation.*[8]
>
> ***— Secretary Henry L. Stimson, 9 August 1940***

The most influential push to expand the war came on 16 May 1940, when Roosevelt shocked the nation by calling for 50,000 planes a year. Even though the number now appears to have been more of a psychological target, used to accustom planners to think big, its effect was momentous.

Perhaps the most significant effect was to correct a situation where Congress, through is appropriations power, determined Army aircraft requirements, rather than by a true study of Army needs. Congress now began appropriating liberally with little question. This created an incredible burden on AAF program managers to

decide how to use the large influx of funds to meet the AAF original goal of 36,500 aircraft per year (their share of the 50,000).

The AAF officers worked day and night to complete the contracts, signing as many as 1,000 a day at Wright Field, Dayton, Ohio, for everything from boots to bombers. Indeed, the billions of new dollars threw the AAF procurement system into a maelstrom of activity. As an observer said, the clarity of the President's 50,000 goal soon became a "hodgepodge of piecemeal appropriations, overlapping procurements, compromises in timing, and uncertainties in composition."[9]

Therefore, program management became the ability to deal with a patchwork of programs that were each a compromise or an *ad hoc* solution. Industrial mobilization became, by necessity, makeshift and disordered, demonstrating why number goals, procurement and production organizations, and the production record constantly changed throughout the war.[10] Consequently, trial and error formed the basis upon which many of these changes were made, which was certainly evident in the evolution of government organization for production.

In late May, the President summoned the National Defense Advisory Commission (NDAC) to Washington. The Commission was composed of seven industrial specialists, and included General Motors president William S. Knudsen. He established the NDAC production division and negotiated for the placement of Air Corps materiel orders, helped allocate plants, found subcontractors, and decided upon expansions.

The Air Corps had to clear all large munitions orders through Knudsen's office, and he reviewed every contract. This did not mean the Services relented control of their own procurement. Rather, the NDAC, and later the Office of Production Management

BOMBER PRODUCTION IN WWII: THE B-24 LIBERATOR

The AAF paid more attention to the bomber, specifically the heavy bomber, than any other airplane. The AAF leaders believed that high-altitude daylight precision bombing was the key to air war success. We will examine briefly the acquisition of the bomber whose production volume exceeded that of all others, the Consolidated-Vultee B-24 Liberator.

The earliest phases of B-24 design began in September 1938. In January 1939, Arnold petitioned the Consolidated Aircraft Company to produce a four-engine bomber with a range of 3,000 miles, a top speed above 300 mph, and a ceiling of 35,000 feet. All specifications exceeded that of the in-service B-17, and Air Corps officials saw it as a superior aircraft. With its crew of 10, the B-24 could carry a heavier bomb load (2,500 lbs.) and carry the load farther (2,850 miles). The Army contracted in March 1939 for a prototype which was produced and test flown in December.

The Air Corps determined that the heavy bomber production was too great for one manufacturer and helped form a manufacturing pool for the B-24 consisting of leading aircraft manufacturers, Consolidated and Douglas, and Ford Company, manufacturer of engines. Douglas and Ford were tasked to aid Consolidated by providing 100 planes per month above what it could produce. This arrangement enabled the AAF to receive the bombers when it needed them. These manufacturers did not complete the first production until June 1941, and the 500th acceptance did not occur until a year later in 1942.

By January 1942, some manufacturers were subcontracting almost 50 percent of their work. Experts have estimated that subcontracting accounted for up to 30 percent of all the poundage of aircraft produced during the war. Subcontracting was especially common for the bomber producers because production was so complex. Consolidated depended on as many as 100 subcontractors, many of whom also depended on subcontractors. Still, this number is nowhere near the more than 1,000 subcontractors Boeing used in producing the B-29. Approximately 162,000 subcontractors contributed to the aircraft industry.

The accelerated production rate record revealed much about B-24 acquisition and answered the question: Just how fast could a plane designed in the late 1930s and early 1940s be mass-produced and put to use? The time between design commencement and the 500th acceptance was 3.5 years — remarkable considering the plane's size and complexity. The most significant year for producing heavy bombers of all types was 1942, particularly in terms of the weight produced (an 862 percent increase over 1941). Though aircraft production costs increased from 1940-45, the cost of producing a B-24 decreased significantly due to the increased efficiency from volume production.

The Liberator proved effective in many utility roles and combat theaters. Like many aircraft it came in numerous versions, reaching all the way to the B-24M modification. Quantity production began at model D, which along with models H and J saw the most combat. The B-24 was also a successful tanker and transport. Pilots in action from Burma to Nazi-occupied Europe, from the Aleutians to the Mediterranean, and from Japan to Germany hailed the twin-tailed Liberator as one of the sturdiest and most dependable planes. The plane's successes were widespread, but, like any aircraft, it had its faults, including weaknesses in armament and armor.

TABLE 2. Aircraft Design to 500th Airframe Acceptance

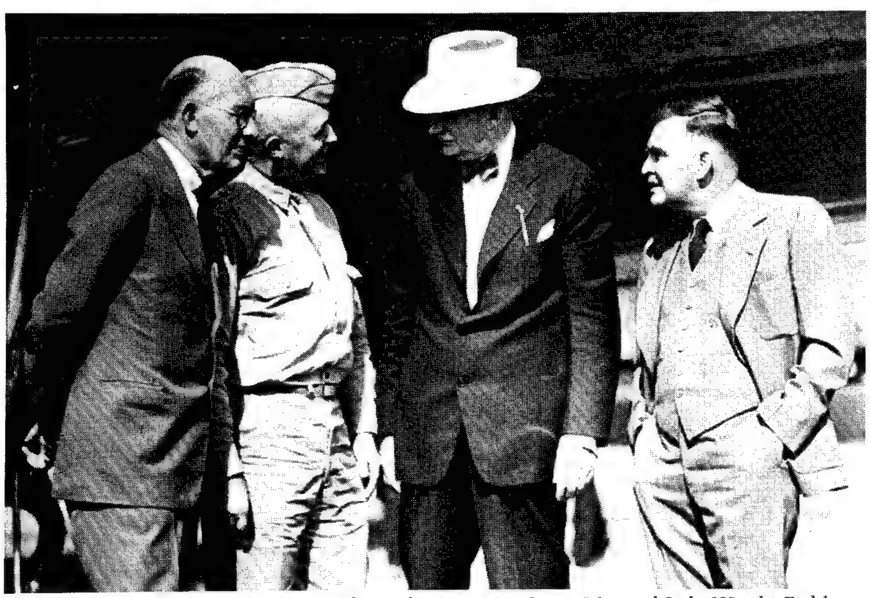
Start of Design	Prototype First Flown	First Production Article	500th Acceptance	Approximate No. of Years
B-17 ...... Aug. 1934	1935	1939	Apr. 1942	7.75
P-39 ..... June 1936	Apr. 1939	Sept. 1940	Oct. 1941	5.25
A-20* 1937	1938		May 1941	4
P-40 .... Mar.1937	Oct. 1938	May 1940	Nov. 1940	3.5
P-38 ..... June 1937	1938	Sept. 1940	Apr.1942	4.75
B-25 ...... Feb. 1938	Feb. 1941	Feb. 1941	Apr. 1942	4.25
B-24 .... Sept. 1938	Dec. 1939	June 1941	June 1942	3.75
B-26 ..... June 1939	Nov. 1940	Feb. 1941	July 1942	3
P-51 ...... May 1940	1940	Aug. 1941	May 1942	2
B-29 ..... June 1940	Sept. 1942	July 1943	July 1944	4
P-47 ....July 1940	May 1941	Dec. 1941	Dec.1942	2.5
A-26 ...... Jan. 1941	July 1942	Sept. 1943	Nov. 1944	3.75

*The A-20 was originally the Douglas DB-7, and the first production article probably flew in 1938 or early 1939. It is likely that the 500th acceptance occurred before May 1941.
Source: *The Army Air Force in World War II: Men and Planes*

(OPM) and the War Production Board (WPB), devoted themselves to providing the raw materials, tools and facilities necessary to produce weapons and equipment, not to controlling procurement.

Roosevelt replaced the NDAC with the OPM at the end of 1940. This agency was less advisory and more authoritative, and included the Secretaries of War and the Navy and a director, Knudsen. Even though it had more power to act, the President felt that the OPM suffered from a lack of real supervisory authority over military acquisition practices. So, in January 1942, he replaced the OPM and its operating agency — the Supply, Priorities, and Allocations Board — which was also a failure, with the WPB.

By this time, the fear created by the Japanese attack on Pearl Harbor on 7 December 1941 had caused American industrial leaders to change their minds about economic regimentation.



Courtesy Air Force Academy Archives

Government and industry leaders confer at the Army Air Corps Materiel Lab, Wright Field, Dayton, Ohio, in August 1940. From left to right: Charles F. Kettering; Major General Henry H. Arnold; William S. Knudsen, Director of the National Defense Advisory Commission; and E. V. Rippenville, director of the General Motors Research Laboratory.

Before then, Roosevelt would have exercised bad politics to give any real authority to the WPB predecessors, despite the fact that government control was the norm in the 1930s. Anyhow, with the creation of the WPB, the Army-Navy Munitions Board now had to report to the WPB Chairman, Donald Nelson, who would check the requirements of the Services according to the availability of materials. The WPB exceeded the effectiveness of its predecessors because it had the power to collect the facts from the Services.

The Joint Air Advisory Committee, which the Army and Navy coestablished in 1940, was also instrumental in organizing production. It probably could have continued the task of coordinating procurement within the two Services were it not for the overwhelming presence of foreign aircraft contracts. These made it necessary for Stimson to appoint a new committee, the Army-Navy-British Purchasing Commission Joint Committee, which later became known as the Joint Aircraft Committee (JAC). Included on the JAC were two members each from the Army, Navy, British Purchasing Commission and the OPM. It had the power "to schedule the delivery of, and allocate the capacity for, aircraft and aircraft components in the official program for all customers, Army, Navy, and British, and other Foreign and Commercial."[11] The JAC also had a final say on matters relating to standardizing aircraft and aircraft components.

Aviation Objectives And AWPD-1

The Air Corps wasted no time responding to the call for 50,000 planes. The first response, called the Army's First Aviation Objective, included plans to expand the Air Corps to 54 combat groups (4,006 combat aircraft) and six transport groups. Stimson approved this on 12 July 1940. Shortly after this Objective was underway, Marshall wrote the Army's Second Aviation Objective to augment exist-

ing groups. But the number of planned groups shot up to 84, including 7,800 combat planes. On 14 March 1941, Stimson approved the second Objective, believing it was "necessary for hemispheric defense."[12]

Arnold directed the AAF Air War Plans Division (AWPD) to answer Roosevelt's request for production requirements to defeat potential enemies. The small group who developed the response, AWPD-1, went far beyond Roosevelt's and Arnold's expectations. Completed in August 1941, AWPD-1 was the first major strategic air war plan of the AAF, marked the zenith of prewar air force doctrine, and provided a blueprint for the air war to follow.[13]

Expecting the United States would fight an offensive air war, the AWPD-1 planners called almost exclusively for the production of long-range bombers. Planners expected that by 1943 or 1944, the AAF would include 203 combat groups, 108 observation squadrons, and a total of 59,727 airplanes, of which the majority would be bombers and trainers. Even Arnold thought it peculiar "that the plan called for only 13 experimental escort fighters but called for 3,740 of the 4,000 mile-range bombers, when the latter would be just as much a developmental problem as the former."[14]

Although the Joint Army-Navy Board did not accept AWPD-1 entirely, the plan still constituted the definitive statement of AAF strategic and production needs as the winter of 1941-42 approached. The AWPD-1 planners were not far off in their ultimate goal of 239 groups by the end of the war; in 1945, 243 groups had been equipped.

America on the Verge of War

Late in 1941, the AWPD produced AWPD-4, "Air Estimate of the Situation and Recommendations for the Conduct of War." It proved too bold a step for the Joint Chiefs of Staff (JCS), and in January 1942, they voted

Courtesy Air Force Academy Archives

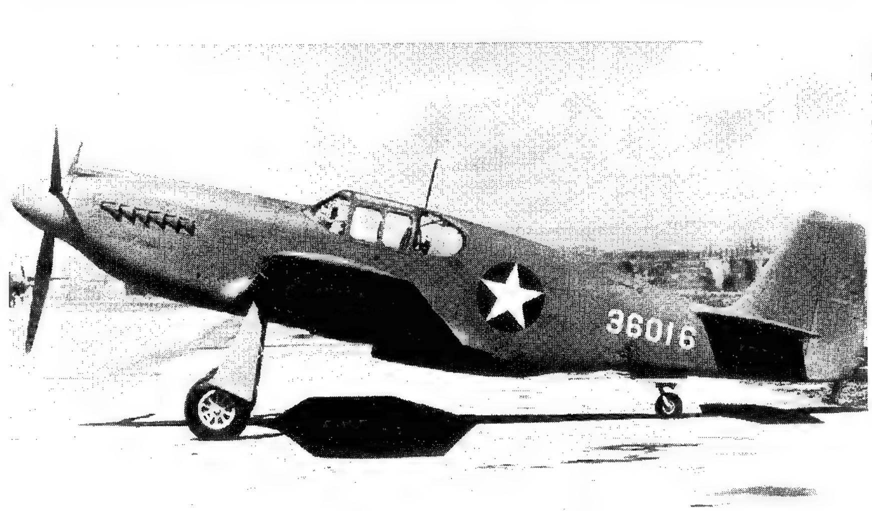
General Henry H. "Hap" Arnold, USA, commander of the Army Air Forces in World War II.

instead to accept AWPD-1 with modifications. The message was that airmen must accept that mobilization of all military forces meant a reduction in the aircraft production priority.

The AAF received a measure of autonomy on 9 March 1942, when the War Department was consolidated into three coordinate forces, each under a commanding general. They were the Army Air Forces, the Army Ground Forces (AGF) and the Services of Supply (later the Army Service Forces (ASF)). General Headquarters, the Office of the Chief of Air Corps, and the Air Force Combat Command all became defunct.

The AAF mission was "to produce and maintain equipment peculiar to the Army Air Forces, and to provide air force units properly organized, trained, and equipped for combat operations."[15] The AAF literally became a subordinate command within the Army, which did not indicate autonomy, but in actuality the AAF became a separate force more similar to the Army and Navy than to the AGF or ASF. Arnold was made a member of the JCS and the Combined Chiefs of Staff on an equal plane with Marshall, technically his superior. The unique nature of AAF acquisition made it necessary for the AAF to deal with such matters within its branch rather than let the ASF do it for them. Coordination problems between the two agencies were not uncommon, but essentially the AAF was its own force.

Arnold submitted a new plan, AWPD-42, "Requirements for Air Ascendancy," which requested 131,000 planes, of which the AAF's share would be used for 281 groups. The Navy sharply challenged Arnold, forcing him into a compromise of 107,000. Although this in effect marked the end of the aircraft transcendent priority among categories of munitions, airmen had little cause for complaint.



Courtesy U.S. Air Force

Early war model of the P-51 Mustang similar to the one built for British use. Readers may note its similarity to the popular high-performance British Spitfire.

Instead, many AAF leaders feared that an abundance of planes might outrun the availability of air crews or shipping to support them in combat theaters.[16] The AAF had been assured it would get the necessary material to prosecute its war.

After Pearl Harbor, the Aircraft Production Division became almost separate within the WPB, leading to the development of an Aircraft Production Board (APB) in December 1942, under the leadership of WPB vice-chairman Charles E. Wilson. The WPB soon assumed central direction of all aircraft production including scheduling, and established the Aircraft Resources Control Office (ARCO) as its executive agency. This agency acted for the board in all matters relating to manpower, materials and machine tools, and it directed the efforts of the Aircraft Scheduling Unit. The APB, ARCO and Aircraft Scheduling Unit constituted the most important aircraft production agencies outside the military, while the JAC remained dominated by the military.

The AAF controlled its own acquisition process by establishing the Materiel Command in 1942. Its top staff was in Washington, but its operating arm was at Wright Field. Major

Courtesy Air Force Academy Archives

Major General Oliver P. Echols, Commander, Army Air Forces Materiel Command.

General Oliver P. Echols, commander of the Materiel Command, was Arnold's chief acquisition adviser throughout the war and directed procurement programs. Echols' extensive experience as engineer and administrator made him well qualified. He represented the AAF on the APB, and he or other members of his staff also served on other War Department committees.

The manufacturers provided the final link in the organizational chain by voluntarily forming the National Aircraft War Production Council, Inc., in 1943 to coordinate nationwide efforts. The Council effectively served as a research and information agency and provided a medium of exchange for process improvements to best meet government needs. Some manufacturers pooled resources to obtain the highest quality products, such as the Boeing-Vega-Douglas committee which codeveloped the famous Boeing B-17 Flying Fortress. Without such coordination, the AAF would not have received the B-17 or many other planes in the numbers or when desired.

Massive Expansion: Industry Mobilization

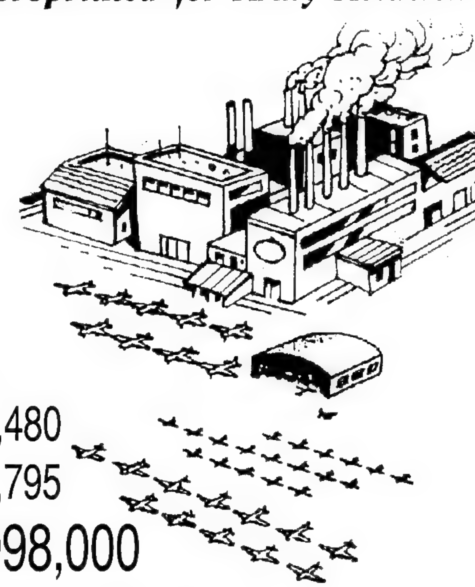
None of the new expansion plants which the government authorized to produce combat planes got into full production until 1943. However, many existing plants had expanded adequately to produce enough planes at least to get the country through the first year of the war. As the barriers which hindered full-scale production before the war dropped, the government pressured producers to build the air force it would need, and made some bold moves of its own. With Assistant Secretary Lovett leading the way, the government contracted for six enormous new assembly plants.

One significant problem was that of balancing mass production (quantity) with quality. Decision makers wrestled constantly with whether or not to freeze design and facilitate production, or to change design and improve quality. One can reasonably assert that perhaps no other problem confronted these officials with hard choices as consistently as this one.

Before the war ended, air arm officials did compromise on the quantity/quality equation by modifying aircraft at one of 20 AAF modification centers. Industry could stablize airframe or engine assembly lines for quantity without worrying about constant change. Quality improvements and changes took place at the centers. The drawback was the high cost, which was, by nature, makeshift and

FIGURE 3. Funds Appropriated for Army Aviation

1931 .... $38,892.,968
1933 .... $25,673,236
1935 .... $30,917,702
1936 .... $50,287,197
1937 .... $62,606,727
1938 .... $67,308,374
1939 .... $74,099,532
1940 .... $243,941,941
1941 .... $3,893,287,570
1942 ...... $21,950,242,480
1943 ...... $10,615,132,795
1944 ...$23,655,998,000



Source: *Procurement in the United States Air Force, 1928-1948: Production Phases 2.*

Courtesy Boeing Archives

B-17 Flying Fortresses, fresh off the Boeing assembly line in Seattle, Wash.

expedient work. By 1943, it became difficult to tell where the production line finished and the modification line began. One center reported 8,000 man-hours modifying a plane that took producers 9,000 man-hours to build.

Another wartime action that contributed greatly to the AAF success was converting the automobile industry. Prior to Pearl Harbor, the automobile industry was one of the only nonaircraft industries that contributed to aircraft production by producing munitions, engines and other parts. Yet, car and aircraft manufacturers were uncertain about how great the automotive industry contribution should be: perhaps smaller, especially to airframe manufacturing. Soon the auto industry was on its way.

First, certain steps were necessary. The WPB halted all civilian passenger-car and light-truck production after 31 January 1942. Industry then organized the Automotive Council for War Production to coordinate dealing with government agencies. Gov-

TABLE 3. Major DPC Facilities Sponsored by War Department

Total Cost — 26 Projects $1,539,985,550

Rank	Company	Locations	Cost to U. S. Government
1	Chrylsler (Dodge)	Chicago, Ill.	173, 647,431
2	Basic Magnesium	Las Vegas, Nev.	132, 695,356
3	General Motors (Chevrolet)	Buffalo, N.Y.	120,055,095
4	General Motors (Buick)	Melrose Park, Ill.	110,009,223
5	Ford Motor	Willow Run, Mich.	86,595,661
6	Studebaker	South Bend, Ind	77,724,127
7	Wright Aeronautical	Lockland, Ohio	74,859,211
8	Wright Aeronautical	Woodridge, N. J.	65,029,598
9	General Motors (Allison)	Speedway City, Ind.	62,541,329
10	Ford Motor (Rouge)	Dearborn, Mich.	59,800,671
11	Dow Magnesium	Velasco, Tex.	56,514,718
12	Mathieson Alkali Works	Lake Charles, La.	48,867,624
13	Dow Magnesium	Marysville, Mich.	42,228,327
14	Continental Aviation	Detroit, Mich.	41,971,682
15	General Motors (Fisher Body)	Flint, Mich.	39,156,924
16	Packard Motor	Detroit, Mich.	38,256,297
17	Curtiss-Wright	Cheektowa, N.Y.	36,386,370
18	Sperry Gyroscope	North Hempstead, N.Y.	36,380,123
19	Wright Aeronautical	Paterson, N. J.	34,113,760
20	North American Aviation	Grand Prairie, Tex.	32,604,623
21	Standard Steel Spring	Madison, Ill.	30,231,525
22	Curtiss-Wright	Columbus, Ind.	29,608,849
23	Thompson Aircraft Products	Euclid, Ohio	29,123,338
24	Higgins Aircraft	New Orleans, La.	28,719,042
25	Boeing Airplane	Wichita, Kan.	26,781,232
26	American Steel Foundries	E. Chicago, Ind.	26,083,414

Each project represents a complete plant or major addition to an existing extablishment. Nos. 15, 21, and 26 sponsored by Ordnance; all others by Army Air Forces. Nos. 2,11 and 13 involved only a contingent liability of War Department; all others required cash-takeout.
Source: *United States Army in World War II: The War Department; The Army and Economic Mobilization.*

ernment and industry transitioned to war production as quickly and easily as possible so that by June 1942 most of the industry had begun conversion. The magnitude and success outdid expectations. By the end of the war, General Motors ranked first in government contracts dollars for aircraft production expansion ($922 million). Even though the automotive industry did not produce many airframes, it did build well over half of all aircraft engines produced between July 1940 and August 1945, and about two-thirds of all combat engines.

Research and Development

The first essential of air power is preeminence in research.[17]

— Lieutenant General Ira Eaker, 6 September 1945

When Eaker made this statement, the AAF had just accomplished what no air force had ever before accomplished. It delivered the *coup de grace* that finished a war. Preeminent research was certainly the impetus behind such a victory, especially when one considers the novelty of the atomic bomb.

American leadership in research and development (R&D) was behind Europe and did not evolve until America declared war. Little aeronautical research took place at American universities, and manufacturers had little incentive to conduct any. The one bright spot was the National Advisory Committee for Aeronautics (NACA), which was responsible for almost all fundamental research prior to and during the war. It was appropriated $2 million each year, and had 500 employees operating at Langley Field, Va.

Despite NACA success, three considerations plagued the Air Corps in December 1941: the assumption that America would fight only a defensive war, the lack of clarification between the Services concerning responsibilities for defense, and a lack of R&D funds. But, war quickly brought American R&D the necessary financial and intellectual resources.

At first, the priority was on the quantity of aircraft produced, rather than quality that springs from R&D. After the first wave of expansion in 1940, Air Corps leaders sought to balance the two, foreshadowing an enormous expansion of R&D into 1945. Expenditures for aeronautics R&D increased from $250 million to more than $800 million. In 1944, the AAF budgeted more than $121.6 million compared to $10 million in 1940. In total, the AAF spent more than 25 percent of all government R&D funds during WWII. The magnitude allowed the AAF, the Navy and the NACA to expand R&D facilities beyond their wildest prewar dreams.

The United States did not lead the way in all new technologies. For example, in jet propulsion we lagged far behind Germany and Britain, a failure described as "the most serious inferiority in American aeronautical development which appeared during the Second World War."[18] Although the AAF accepted 115 jet-propelled P-80s, none actually saw combat.

Congress and the Appropriations Business

During the interwar years, Congress clearly neglected the nation's air arm, constantly disappointing Air Corps officials. Responsibility fell on Congress and everyone who participated in the budgetary process, including military officers. Indeed, the limited funds Congress made available for aircraft procurement reflected a greater problem — the inadequate system of defense budgeting. Also, the Air Corps suffered from a lack of vision in the military and Congress. No one could state the roles or needs of aviation; it was still too new. Had Congress overabundantly appropriated for air, funds likely would have been wasted unless accompanied by a vision and suitably perfected procurement methods.

Congress had made the task of building an air force difficult by enacting legislation which limited profits, ensured competition, forced the military to "buy American," and protected labor. In 1938, Arnold began a campaign for a split-award bill that would modify the profit limitations imposed on all procurement by the Vincent-Trammell law and allow airmen to use certain negotiated contracts. Congress held out on the competition issue because industry made it clear they were opposed to abandoning competition in quantity procurement. It did not pass until March 1940.

Virtually all prewar acquisition problems disappeared when Roosevelt issued his 1940 call for 50,000 aircraft. Where Congress had

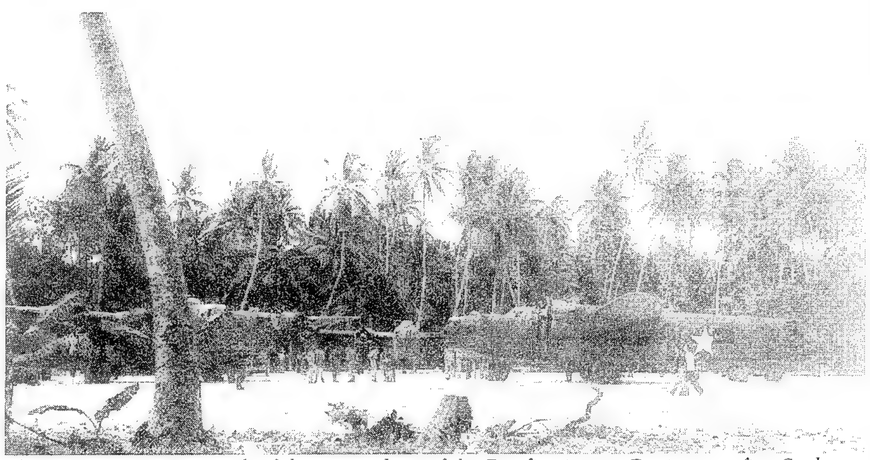
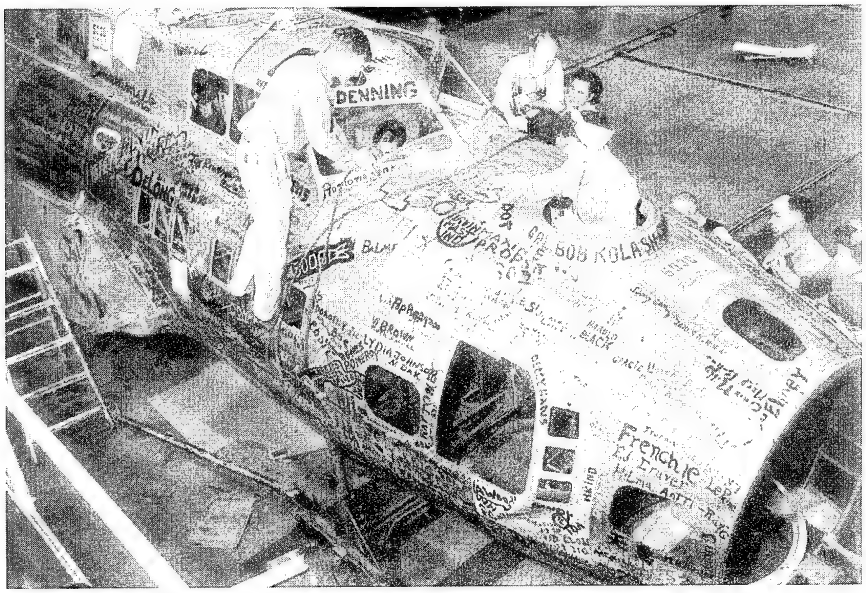


Photo source: Classic Aircraft Bombers, Filmways Co., New York, 1978

This picture captures much of the atmosphere of the Pacific air war. Engineers, often Seabees, hacked out good airstrips on coral atolls and put palm trees to good use, but when the aircraft was the B-24 Liberator, space was often tight and dispersal impossible.



Boeing factory workers mark a milestone B-17 delivery by autographing the fusélage.

previously refused to see the emergency, they now asked, "what can we do to strengthen the nation's air arm; what are your needs?"[19] Congress enacted emergency legislation which cancelled all profit limitations, mandatory competition and strict labor protection, and approved vast appropriations and bills to speed up the procurement process. Thus Congress tried to "buy back yesterday." Congress appropriated more than $72.29 billion for the AAF between 1939 and 1945, gave the military broad discretionary powers, abolished restrictions on contract negotiations, and passed a bill which authorized the President to contract without regard for existing law, when to do so would "hasten the war effort."[20] In effect, after 1939 any blame for difficulties within the Air Corps rested more on the General Staff than Congress. However, the General Staff, "which had viewed the sky through smoked glasses, so to speak, since the days of Billy Mitchell," initially held no vision of air power necessity.[21]

Government Aid to Manufacturers

Because most manufacturers began expansion with neither the necessary capacity nor mindset, and were unwilling to bear the risks alone, they demanded that the government accept some risk. The government then developed specific ways to aid them, and focused on one: The government would own the facility and pay the bills; private industry would do the work.

The Defense Plant Corporation (DPC), organized in August 1940 as a subsidiary of the Reconstruction Finance Corporation (RFC), soon became the foundation upon which the bulk of war plant financing was built. In most cases, the government built the plant through the DPC and then leased it to a private company for operation. The DPC and other government aid proved crucial in the rise of industrial capacity and production. Of the $3 billion the War Department sponsored through the DPC, AAF facilities accounted for 82.6 percent.

Conclusion: the Overall Production Record

Perhaps the greatest indication of the successful expansion of the American aircraft industry and the consequent reign of American air power was the amazing production record. Surprisingly, despite its 1939 inferiority, America was already the world's foremost producer of aircraft on 7 December 1941. In two years we moved from fifth to first rate. Nevertheless, our post-Pearl Harbor production was much more impressive and probably surpassed anyone's wildest imagination.

People thought Roosevelt was using hyperbole in his 1940 call for 50,000 aircraft. But, in November of 1941, America was halfway there, and when the industry reached its peak performance in March 1944, producing 9,113 airplanes that month, the overall annual production rate was an incredible 110,000. Using airframe weight as a measure, the United States outproduced all other nations of the world combined in 1944.

The AAF was the first air arm to play an instrumental role in a nation's victorious war effort. It delivered the final blow to the Japanese in August 1945 by dropping atomic bombs from two Tinian-based Boeing B-29 Super-fortresses, the "Enola Gay" and "Bockscar," on Hiroshima and Nagasaki.

In WWII, the United States demonstrated its greatness by doing what might have seemed impossible when General Andrews told that small group of Saint Louisans in 1939 about the state of America's air arm. How did we carry out such a feat? We did it by realizing the correct combination of factors that made U.S. industry supreme, by analyzing the situation and the resources at hand, and making decisions based on the greatest amount of information possible. True, we did not have to deal with interruptions due to invasion or bombardment, a luxury unlikely in future major conflicts. Nevertheless, those involved in acquiring American air power today should revisit and remember the lessons of WWII and build on that heritage.

Endnotes

1. *New York Times.*
2. *Ibid.*
3. Goldberg, p. 173.
4. Goldberg, p. 174.
5. Zimmerman, vol. 2, p. 1.

6. Zimmerman, vol.1, p. 5.
7. Goldberg, p. 183.
8. Futrell, p. 101.
9. Holley, p. 235.
10. *Ibid.*
11. Goldberg, p. 273.
12. Futrell, p. 102.
13. Futrell, p. 109.
14. Futrell, p. 111.
15. Quoted in Futrell, p. 129.
16. Craven, p. xvi.
17. Quoted in Goldberg, p. 228.
18. Quoted in Goldberg, p. 246.
19. Holley, p. 283.
20. Holley, p. 289.
21. Zimmerman, vol. 1, p. 75.
22. Goldberg, p. 219.
23. *London* [England] *Daily Herald*, p. 30.

Bibliography

James Lea Cate and Wesley Frank Craven eds., *The Army Air Force in World War II: Plans and Early Operations*, January 1939 to August 1942 1 (Chicago: University of Chicago Press, 1948).

James Lea Cate and Wesley Frank Craven eds., *The Army Air Force in World War II: Men and Planes 6* (Chicago: University of Chicago Press, 1948).

Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force*, 1907-1964 (Maxwell Air Force Base: Air University, 1980)

James E. Hewes, Jr., *From Root to McNamara: Army Organization and Administration*, 1900-1963 (Washington: Department of the Army, 1975).

Irving B. Holley, Jr. *United States Army in World War II: Special Studies: Buying Aircraft: Materiel Procurement for the Army Air Forces* (Washington: Department of the Army, 1964).

John Perry Miller, *Pricing of Military Procurements* (New Haven: Yale University Press, 1949).

The New York Times, 17 January 1939.

The Official Guide to the Army Air Forces (U.S.A.: Army Air Forces Aid Society, 1944).

R. Elberton Smith, *United States Army in World War II: The War Department: The Army and Economic Mobilization* (Washington: Department of the Army, 1959).

S.A. Zimmerman, *Procurement in the United States Air Force, 1938-1948: Purchasing Phases 1* (Wright-Patterson Air Force Base: Air Materiel Command, 1950).

S.A. Zimmerman, *Procurement in the United States Air Force, 1938-1948: Production Phases 2* (Wright-Patterson Air Force Base: Air Materiel Command, 1950).

FIGHTER PRODUCTION IN WWII: THE P-51 MUSTANG

The plane that came closest to reaching perfection in design and performance in WWII was the North American P-51 Mustang fighter. The British were the first to realize what a great asset it was and to purchase it, demonstrating again how the United States benefited greatly from foreign orders. In 1941, the AAF operated under the assumption that big bombers could crush the enemy without escort. However, the opposite soon became clear, and the P-51 emerged as the first fighter with the combat range to escort a bomber and also engage in combat with enemy interceptors.

The P-51H had a range of 1,800 miles, a speed of 487 mph, a ceiling of 40,000 feet, and could carry six 50-caliber machine guns or 2,000 pounds of bombs. The Mustang's increased range and other improvements prompted the British to say in 1942 that the P-51 was "the best American fighter that has so far reached this country," and that it compared favorably to the British Spitfire, considered the best fighter in the world.[22] In November 1942, the AAF leaders finally ordered 2,200 Mustangs, but did not get a P-51 group into the European war until a year later.

Despite such a late start, the P-51 production rate was more impressive than that of any other U.S. plane. Its production rate was better than any other aircraft at two years from start of design to 500th airframe acceptance. The designs of most aircraft surfaced in the three years prior to Pearl Harbor due to increased demand. Yet, though every major aircraft was designed before Pearl Harbor, only three — the P-39, the A-20 and the P-40 — had been mass-produced prior to it. These were later eclipsed by superior aircraft such as the P-51.

In Europe, U.S. P-51s did less dogfighting than one would expect of this high-caliber pursuit machine. Instead, its utility was more evident in reconnaissance and tactical bombing. One report in the London Daily Herald labeled the P-51, "the creeping death," because it flew so fast and so close to the ground and yet was so quiet compared to other planes.[23] In Europe, the P-51 strafed and bombed a variety of targets, made an excellent spotter plane, and greatly improved ground-air force coordination. By 1944, the Eighth Air Force in Western Europe had replaced all of its P-47s with P-51s. The Mustang contributed greatly to the overwhelming air superiority the Allies enjoyed after mid-1944.

ANNUAL DOD SOFTWARE ACQUISITION CONFERENCE

Planned for 28-30 November

The Annual DoD Software Acquisition Conference will be held 28-30 November 1994 at the Westpark Hotel, 8401 Westpark Drive, McLean, Virginia, in the Tysons Corner area. The conference will address new directions in software acquisition and emerging software technologies.

Tutorials will be held from 1 to 5 p.m. on Monday, November 28 and offer three parallel tracks from which to choose.

The conference agenda was put together by Program Committee Chairman Jim Heil of MITRE and Defense Systems Management College (DSMC) Professors Jim Dobbins, Lt Col Carlos Galvan, USAF, and Lt Col Jim Craig, USAF.

The conference itself kicks off on Tuesday morning, November 29, with a keynote address by Anthony Valletta, Deputy Assistant Secretary of Defense (C3I Acquisition).

Other speakers include; Dennis Turner, Director of the Army Communications and Electronics Command (CECOM) Software Engineering Directorate; Dr. John Foreman, STARS Program Manager at ARPA/SISTO; John Hovell, Chief, Training at the Defense Information Systems Agency (DISA); Lt Col Robert Lyons,USAF, Air Force Aeronautical Systems Center, WPAFB; Dr. Raghu Singh, of the Naval Space and Warfare Command (SPAWAR); Jack Cooper, President of Anchor Software, and Chairman of the National Security Industrial Association (NSIA) Software Committee; Joanne Arnette, Software Systems Directorate, DISA; Don Reifer, Director of the DoD Software Reuse Initiative, and Acting Director of the Ada Joint Program Office.

Also speaking are Dr. Clyde Chittister, Program Manager at the Software Engineering Institute (SEI); Michael Olsen and Chris Sittenauer, of the USAF Software Technology Support Center (STSC), Hill AFB, Utah; Lisa Browsword, Manager of Office of the Secretary of Defense (OSD) Programs at SEI; George Winters, Project Leader at SEI; James Heil and Christine Thorsen, MITRE Software Engineering Center; Doug Putnam, Senior Consultant at Quantitative Software Management; Dr. Issa Feghali, Senior Associate at McCabe & Associates and professor at Marymount University; Taz Daughtrey, Babcock & Wilcox Naval Nuclear Division, and past chairman of the ASQC Software Division; and Sherwin Jacobson, Chair of the Software Management Deptartment, DSMC, and Jim Dobbins.

The Tutorials feature three speakers, Dobbins, Joseph Billi (MITRE), and Jack Cooper.

For information, call Stephen Taylor at Education Foundation Data Processing Management Association, (310) 534-3922.

"FIFI" FLIES

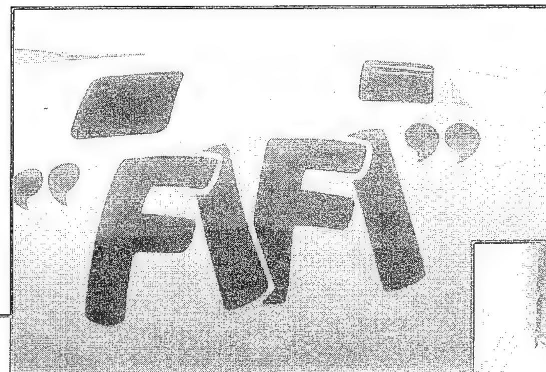
Classics That Won the War Still Thrill

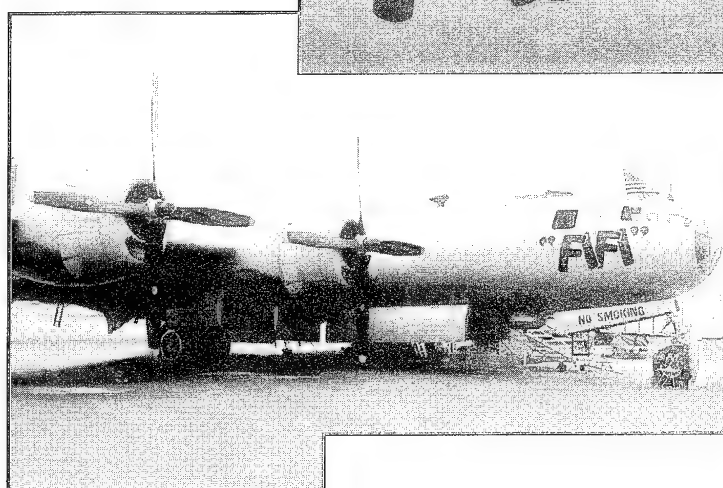
By midafternoon on 9 July 1993, the torrid heat of a 100-degree Virginia summer had turned the Manassas Airport tarmac into a steam iron. I went randomly from plane to plane, heavy camera case over my shoulder, joining a few hardy buffs inspecting the collection of Confederate Air Force (CAF) classics of World War II (WWII) in their occasional fly-in.

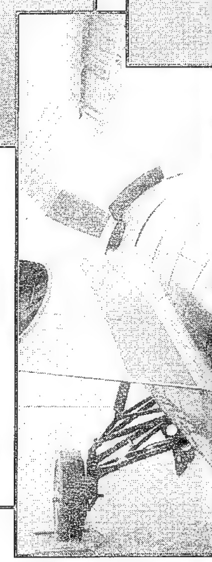
I had come mainly to see "Fifi," the only B-29 Superfortress still flying.* "Fifi" is a model similar to the famous "Enola Gay," which delivered the first atomic bomb to Hiroshima on 6 August 1945, and her sister ship, "Bockscar," which hit Nagasaki three days later with the second. The bombs knocked out Japan and ended the war. The long-range Superfortress was sleeker, more powerful, and carried a larger bomb load than any other plane built.

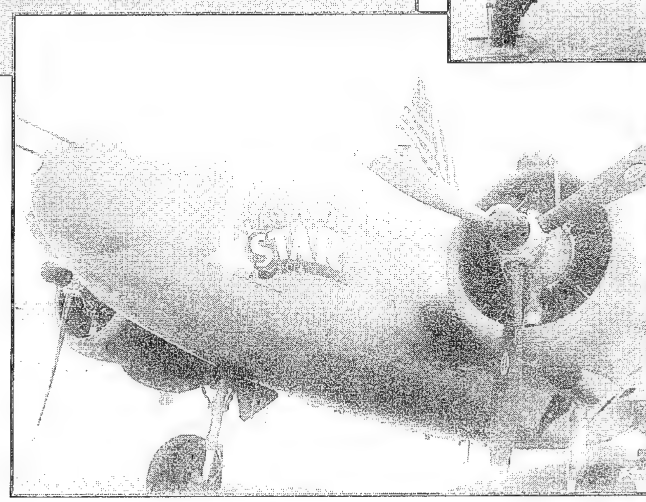
"Fifi" flew during WWII, but only saw action in the Korean War before being retired to the California desert. There, the CAF resurrected her from the U.S. Air Force, and by 3 August 1971, she was ready to fly to her new home, Harlingen, Texas. After three years of fund-raising and hard work, the new addition to the CAF was fully restored to WWII specifications and began participating in air shows around the country.

I paid the requisite fee and clambered aboard "Fifi" the way her 1945 crew would have — up the aluminum ladder leading to the cockpit area. The heat and humidity were stifling inside the cramped quarters. The pilot and guide said the temperature was 115-120 degrees. Nevertheless, I was spellbound. I sat in the pilot's seat for at least 15 minutes, imagining what might have been, as my historian instincts have conditioned me to do. Taking in the navigator's table, the radioman's niche, and the long access tunnel over the bomb bays to the mid- and after-sections, my mind swirled with thoughts of those brave men flying in abominable conditions in hours upon hours of flight time to targets in Japan from faraway bases in the Mariana Islands. I was 10 and 11 then, and have vivid recollections of this and many other wartime events of 50 years ago that turned my boyhood upside down and helped





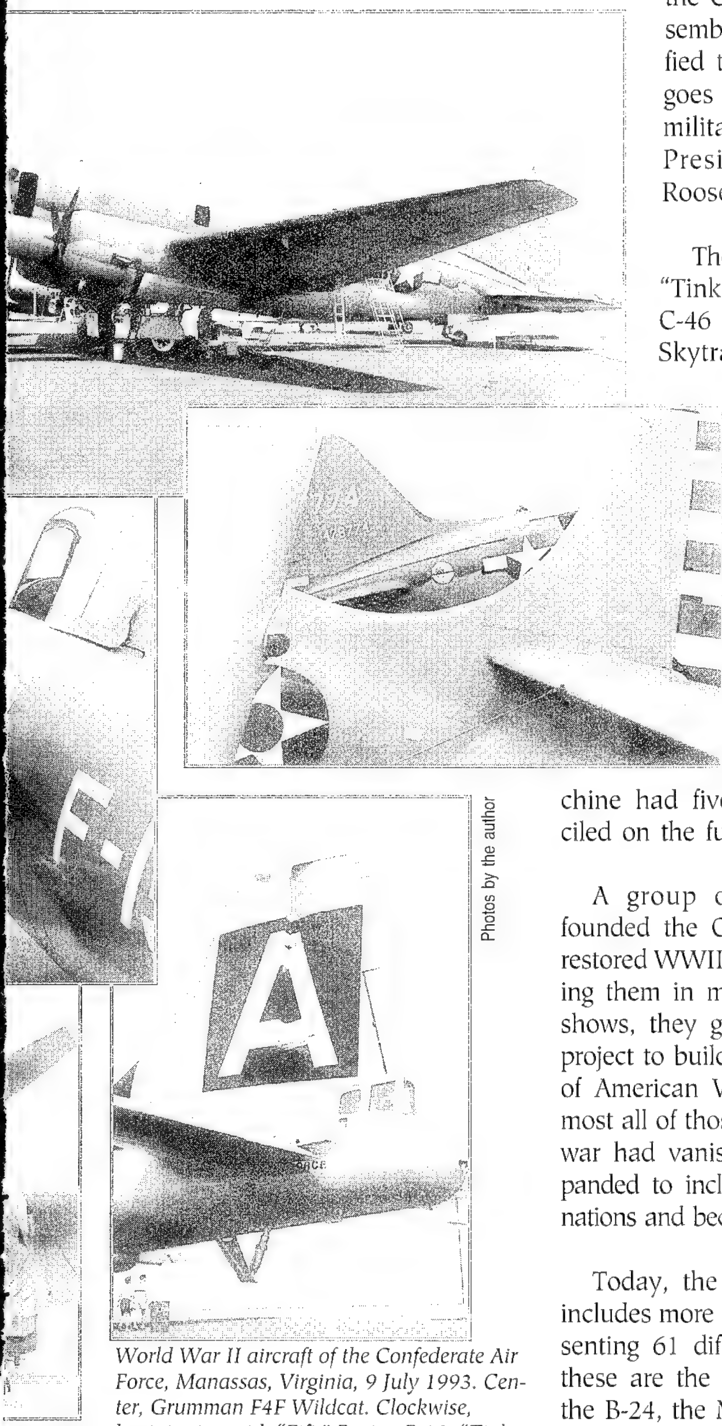




*World War II plane crews often nicknamed their machines; these names were painted on the nose section: female names were very popular.

shape my life, like many others of my generation.

Though the Boeing B-29 stimulated most of my imagination, enough remained as I investigated the interior of "Diamond Lil," the last B-24 Liberator still around. As Cadet Jeremy Marsh reports in his splendid article, more B-24s were built than any other U.S. airplane, 5,500 more than the better-known Boeing B-17 Flying Fortress and nearly 8,000 more than the rugged Douglas C-47 Skytrain, the workhorse DC-3 of commercial aviation. "Diamond Lil" was the 25th off the Consolidated-Vultee assembly line, and was modified to fly high-priority cargoes and top civilian and military leaders, including President Franklin D. Roosevelt.


Photos by the author

World War II aircraft of the Confederate Air Force, Manassas, Virginia, 9 July 1993. Center, Grumman F4F Wildcat. Clockwise, begininning with "Fifi," Boeing B-29; "Tinker Belle," Curtiss C-46 Commando; C-46 and F4F tail sections; B-29 tail section; and "Lady Lodestar," Lockheed C-56 Lodestar.

The CAF display included "Tinker Belle," the Curtiss C-46 Commando, the C-47 Skytrain's companion but larger transport renowned for flying "The Hump" over the Himalayas between India and China; "Lady Lode Star," the Lockheed C-56 Lodestar transport; and the Navy's early war carrier fighter, the Grumman F4F Wildcat. This machine had five Japanese kills stenciled on the fuselage.

A group of ex-military pilots founded the CAF in 1957 with two restored WWII American fighters. Flying them in military and civilian air shows, they generated interest in a project to build a complete collection of American WWII planes. But, almost all of those produced during the war had vanished. Their mission expanded to include aircraft from other nations and became a worldwide effort.

Today, the CAF Flying Museum includes more than 140 aircraft representing 61 different types. Many of these are the only known survivors: the B-24, the Martin B-26 Marauder, the Curtiss SB2C Helldiver, and the Mitsubishi A6M Reisen (Zero) (one of two flyables left). The CAF has more

B-29 COMBAT MILESTONES

First Combat Mission
June 5, 1944, against railyards, Bangkok, Thailand. Mission originated in India.

First Combat Mission against Japan
June 15, 1944, against steelworks, Yawata. Mission originated in China.

Longest Single-Stage Combat Mission
August 10, 1944, from China Bay, Ceylon, to Palenbang, Sumatra (3,900 miles).

First Combat Mission from the Marianas
October 28, 1944, against submarine pens at Dublon Island.

First Combat Mission against Japan from the Marianas
November 24, 1944, against Tokyo.

Largest Number of B-29s Launched on a Single Day
August 1, 1945, 836 launched, 684 reached their targets.

Last B-29 Combat Mission of WWII
August 14, 1944 (741 launched).

B-29 MILITARY SPECIFICATIONS

Maximum Speed (at 25,000 ft.)	310 mph
Cruising Speed	220 mph
Service Ceiling	33,000 ft.
Gross Weight (military load)	147,000 lbs.
Wing Span	141 ft.
Fuselage Length	99 ft.
Range	3,700-4,500 miles (depending on fuel and bomb load)
Standard Armament	12.50 caliber machine guns
Bomb Load	20,000 lbs.
Fuel Capacity	
Wing Tanks	5,828 gals.
Center Tank	1,120 gals.
Oil Capacity (each engine)	85 gals.
Engines	4 Wright Cyclone 18-cylinder R-3350 2,200 HP each

The box article and the right column continue from a previous page.

WINGS OF FREEDOM

at the Confederate Air Force World War II Airpower Demonstration

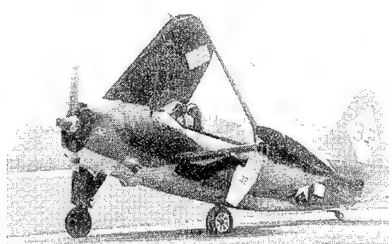
Frederick, Md., 27 August 1994 — The roars of "Diamond Lil," "Fifi," "Memphis Belle," "Gunfighter," the Zeroes, Kates, the Helldiver, the Heinkel and the immaculate Navy blue Corsair — the fighter the Japanese called the "Whistling Death" — shook the brilliant sunsplashed sky here this afternoon.

To the World War II enthusiast, nostalgia lived and little else mattered, as the chronicle of the war by air was reenacted to the pleasure and reverence of thousands of onlookers by the exceptional professional performances by aviators of the Confederate Air Force (CAF). I would not have missed the show for any reason, and wanted to share some photos and observations.

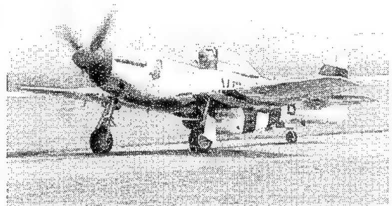
For this demonstration, the CAF flew in "Memphis Belle," a Boeing B-17; "Chapter XI," a North American B-25 Mitchell; "Gunfighter" and "Donald Duck," two North American P-51 Mustangs; a Curtiss P-40 Warhawk; four North American AT-6/SNJ Texans; a Chance Vought F4U Corsair; a Curtiss SB2C Helldiver; a Douglas C-47 Skytrain; a Beechcraft AT-7 Kansan; and an Interstate L-6 Grasshopper. "Diamond Lil" and "Fifi" flew over from Martinsburg, W.Va., and remained airborne. Relics of our former enemies were there, including the sole flying Zero and three replica Zeroes, several Nakajima B5N Kate replicas, and a Heinkel He-111 (which ferried Generalissimo Franco around during the Spanish Civil War).

If you have the opportunity to see this marvelously scripted flying demonstration of American history, don't miss it.

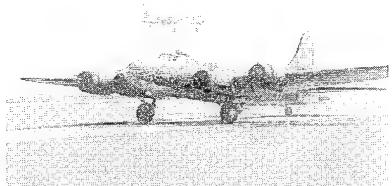
WDJ, Jr.



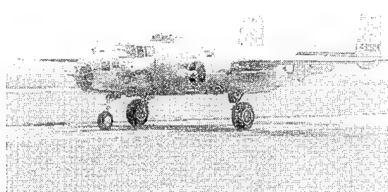
Curtiss SB2C Helldiver



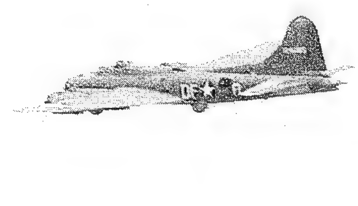
"Donald Duck," North American P-51D Mustang



"Memphis Belle" and Douglas C-47 Skytrain (airborne)



"Chapter XI," North American B-25J Mitchell



"Memphis Belle," Boeing B-17F Flying Fortress

than 93 chapters around the world. For more information, contact the Confederate Air Force, Inc., 313 Hanmore, Harlingen, Texas 78550. The telephone number is (210) 428-5081.

Classics of WWII also are sure to fly at two annual U.S. air shows of note, at Dayton, Ohio, and Oshkosh, Wis., both held in late July. These are well worth a trip to anyone interested in flyable aviation classics of all ages. The U.S. Air and Trade Show (Dayton Air Show) telephone is (513) 898-5901. While in Dayton, the visitor must browse the U.S. Air Force Museum (telephone (513) 255-3284) at Wright-Patterson AFB, which boasts more than 200 aircraft and is home to "Bockscar." The Oshkosh Fly-In Show is associated with the convention of the Experimental Aircraft Association (museum telephone (414) 426-4800).

The "Enola Gay" soon will be displayed at the National Air and Space Museum as the centerpiece in the exhibit, "The Last Act: The Atomic Bomb and the End of World War II." Scripting for the exhibit has been controversial and criticized by veterans' groups. At this writing, the Smithsonian reports its attempts to refocus and balance the exhibit.

No, nothing could stop the Army Air Corps, just like the fight song said. As the wartime propaganda poster blared to us — do your part for the war effort and "Keep 'em Flying!" And we have, over all these years.

—Wilbur D. Jones, Jr.

Mr. Jones is Associate Dean of Information, DSMC.

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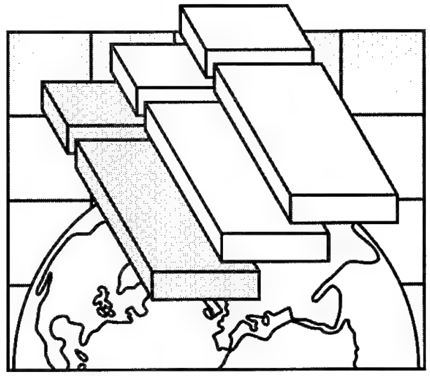
1995 ACQUISITION RESEARCH SYMPOSIUM



Sponsored by the Deputy Under Secretary of Defense (Acquisition Reform)
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The 1995 theme is "**Acquisition for the Future: Imagination, Innovation, and Implementation**," and the subtheme is "**Acquisition Reform: A Mandate for Change — Reengineering the Acquisition Process**." Papers that address the theme, subtheme and current issues in acquisition management will be especially relevant. Topic areas include:

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To be considered, all papers should include the **Title, Topic Area, Author(s) Name, Business Address and Telephone Number**. If a paper is submitted with more than one author, the primary author should be listed first. All communications will be addressed to the primary author. Paper guidelines are available upon request to: Ms. Joan L. Sable, DSMC Program Co-Chair, at (703) 805-2525/2289 or DSN 655-2525/2289.

Prospective authors must submit *three copies* of their paper and, if possible, electronic media on a 3 1/2" disk no later than ***February 24, 1995***. Paper will be evaluated to be accepted as session presentations and/or published in the ***1995 Acquisition Research Symposium Proceedings.***

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Paper Deadline:	***February 24, 1995***
Notification:	***April 1995***
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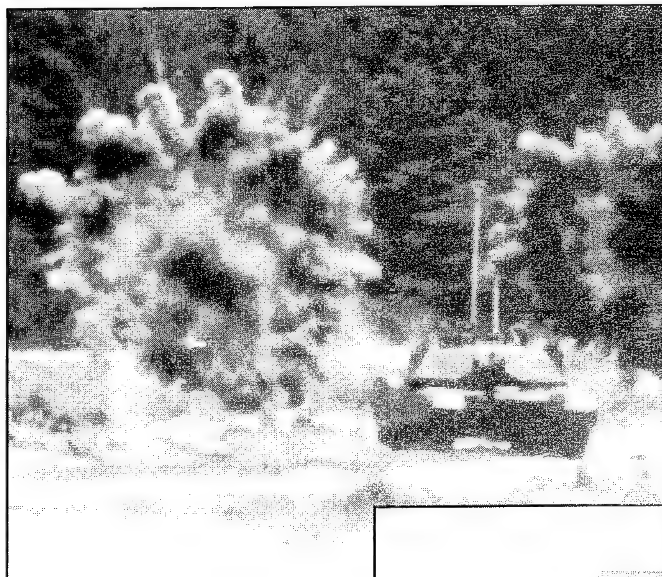
SHELVING TECHNOLOGIES

Breaking the Acquisition Strategy Mold

Thomas C. Hoff

With Department of Defense (DoD) budget reductions and more planned for the future, more and more military items may be developed without necessarily going directly into production. This scenario occurred in one such program — the discharger, grenade, smoke, countermeasure — the M6. The M6 Discharger, pictured on the next page, is designed as the next-generation, smoke-grenade discharger for use on future vehicles. It consists of four fixed tubes for launching smoke grenades for the defensive obscuration of military vehicles. Since the development of the discharger was ahead of that of future vehicles, two options existed: (1) defer the end of the development program until a user is identified, or (2) end the development program but hold off on production until the item is needed. Option 2 was selected and truly makes the most sense, until U.S. Army regulations come into play.

At what point is a development program considered complete? Usually this is at Milestone III - "Type Classification." Type classification (TC), according to Army Regulation (AR) 70-1, "Army Acquisition Policy,"[1] is the process identifying the degree of acceptability of a materiel item for Army use and provides a guide to authorization, procurement, logistical support, and asset and readiness reporting. It is an integral part of the Milestone III production approval process. The TC is the Army's implementation of the DoD requirement that an item is "approved for Service use" before expending procurement funds (DoD Instruction 5000.2, Part 3.g).[2] Again, it might be appropriate to complete the development effort by conducting a Milestone III In-Process Review (IPR), type classify the item, and have no immediate production plans in place. However, AR 70-1. Para 3-2.c(2) of AR 70-1, which does not allow this, specifically states "Items will only be type classified for introduction into the force if procurement is planned within the current Program Objective Memorandum (POM) period."

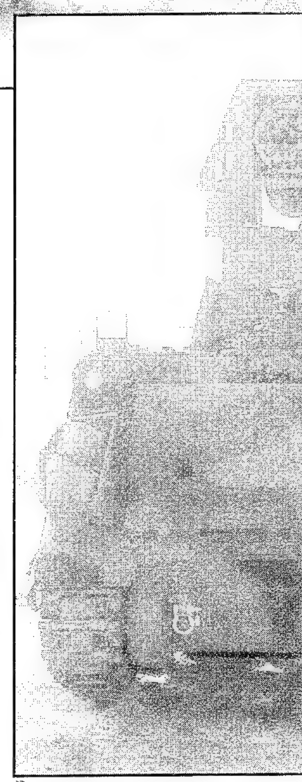


A.

Exploring Alternatives

The previous excerpt does not appear to be vague or subject to interpretation. It is straightforward; no production dollars equals no TC. How would you, then, come to an orderly conclusion of the development effort? A commitment to procure was not sought, only a recognized completion point — a specific point in the life cycle that is identified with the completion of the development effort. Two alternatives were explored. First, use some other predetermined milestone which would signify the completion of development without TC, or type classify the item (either by pursuing a waiver or being in conflict with the AR).

This first option, interpreted as completing the development of the item just short of type classification, appeared to be viable. This way, AR 70-1 would not be violated. However, not holding the Milestone III IPR would require that one be held

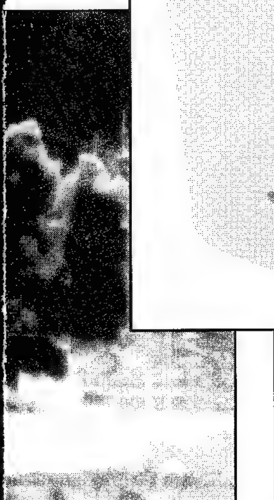


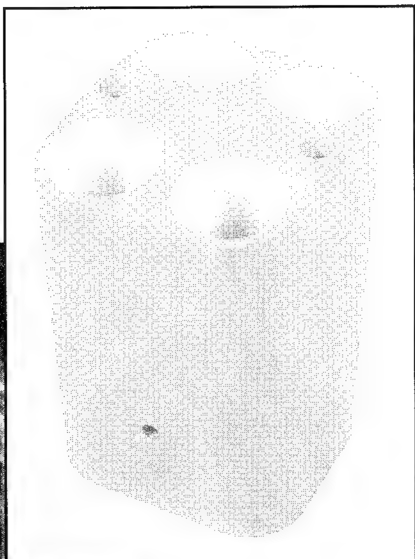
B.

Mr. Hoff is Rapid Obscuration System Manager, U.S. Army Edgewood Research, Development and Engineering Center (ERDEC), Aberdeen Proving Ground, Md.

later — probably right before production. If this IPR took place years after the development effort, names and faces of IPR members would have changed as well as, quite possibly, the regulations governing the process. Issues that likely come up during an IPR, a testing concern for example, would probably be easier to resolve if the testing was completed recently and if the same personnel were still involved in the program. A timely wrap-up of all loose ends made more sense, that is, really complete the development effort by convening an IPR as soon as possible. So, the first option was not pursued.

The second option was chosen. Using the premises that "regulations are just guides" and a mindset to "break the mold," a Milestone III IPR was scheduled. Following this strategy, the plan was to TC the item and shelve the Technical Data Package (TDP). This brought up another concern - how do you shelve a TDP? What does this mean? Like anything else in the development cycle, regulations must exist that govern the shelving process. Little guidance was found on shelving procedures, since this was in conflict with the regulation. So, as a minimum, a shelving plan was formulated. The purpose of this plan was to ensure an orderly transition of information and concerns from the development effort to the production effort. The Shelving Plan for the M6 Discharger was separated into three sections: (1) TDP, (2) Logistics Support Analysis, and (3) Interface for the Vehicle.

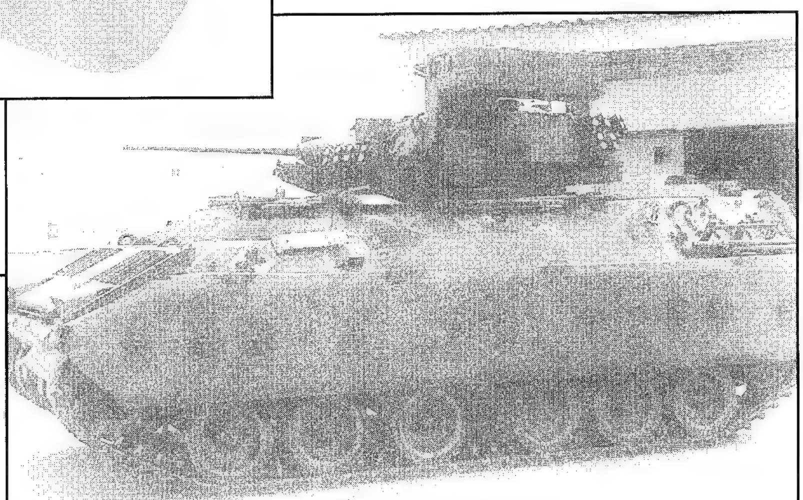




Photos courtesy of the ERDEC Audio Laboratory

C.

D.



A. The M2 Bradley tests smoke grenades launched from the M6 Discharger.
B. The M6 Discharger mounted on an experimental vehicle.
C. The M6 Discharger.
D. The M6 Discharger mounted on the M2 Bradley.

The TDP Shelving Plan

The TDP Shelving Plan includes recommendations for alternate sources and methods of manufacture and inspection not verified in development and, thus, not formally part of the TDP. This information is available and should be made part of the permanent record for future use — as for a preproduction evaluation (PPE) effort.

The M6 Discharger, as with all smoke grenade launchers, does not have a separate technical manual. Information on the operation and maintenance of the discharger is provided in the associated technical manuals for the host vehicles. Since host vehicles have yet to be identified, these manuals have not been generated. Therefore, a portion of the Shelving Plan was developed to document the results of the logistics support analysis conducted by the M6 development team. This information will assist host vehicle developers in creating technical documentation associated with operating and maintaining the M6 Discharger.

Interface data also was documented in the shelving plan. Mounting hardware and cabling connecting the M6 to the host vehicle is vehicle specific and not part of the M6 Discharger TDP. For test and demonstration purposes, mounting hardware and electrical connectors were developed for two currently fielded systems. This information could assist other host vehicle developers in creating the interface for the M6 Discharger.

The aforementioned shelving information was compiled and included in the M6 TDP as an advisory note to

the top assembly drawing. As part of the TDP, it ensures the information is provided to the production team, if and when production of the item begins.

Now it appeared everything was in line to Type Classify the M6 and shelve the TDP until production is identified. Important to point out is that there were no "show stopper" issues relevant to the hardware. The M6 Discharger had met its technical and operational requirements and the prerequisites of the Milestone III decision had been fulfilled — that is, except for compliance with AR 70-1.

Several members of the IPR did not have the same interpretation of regulations being guides and breaking the mold. Two members of the IPR did not concur with the Milestone III TC action. Again, this was not due to any shortcoming of the hardware, only due to noncompliance with AR 70-1.

The Technical Director, ERDEC/Milestone Decision Authority, decided to complete the development of the item with a "standard" type classification, not go immediately into production, and shelve the TDP. This breaks the mold of traditional acquisition strategies, as it does not comply with regulations built around the old way of doing business. The DoD budget restraints dictated the most economical, yet technically acceptable, option. This appeared to fit into the new DoD acquisition approach of developing and shelving new technologies. When the M6 Discharger is needed, the production team will be busy but well-prepared.

Endnotes

1. Department of the Army. Army Regulation 70-1, "Army Acquisition Policy," 30 April 1993.
2. Department of Defense. Department of Defense Instruction 5000.2, "Defense Acquisition Management Policies and Procedures," February 1991.

NOW AVAILABLE

AIR FORCE ACQUISITION MODEL VERSION 2.0

The Air Force Acquisition Model (AFAM) Program Office has released AFAM Version 2.0. The AFAM is a computer-based reference tool designed to capture and provide essential information on AFMC processes. The AFAM targets inexperienced personnel by describing what is required to accomplish basic tasks and provides needed reference documentation such as policy, regulations and directives. The model also provides "how" others have accomplished these tasks by capturing the Best Practices, Lessons Learned, and experience/wisdom of personnel who have been in similar situations. The AFAM uses current technology to provide an automated tool that provides acquisition and support knowledge to the workforce with a few clicks of the mouse on their desktop computers.

The AFAM application provides information to assist in the completion of acquisition and support tasks across all functional disciplines. It is designed to assist personnel in performing tasks from preconcept exploration through disposal for weapon system acquisition, modification, and support programs. Task descriptions, references, lessons learned, templates, samples, documents, applicable software tools, and nominal timelines are provided in an easy to use Windows-based environment. Updated semiannually, AFAM provides current and accurate information on acquisition and support processes. Packaged with AFAM is AFAMSUP, a fast text search/retrieval tool, with key documents such as DoD directives, Air Staff or MAJCOM policy letters, regulations, military standards, pamphlets, guides and handbooks. For this release, AFAMSUP has been converted to a Windows environment, giving the user more capabilities for searching through all the reference material.

Version 2.0 of AFAM includes nearly 40MB of information on more than 4,000 tasks, and on-line access to 113 reference documents. A graphical display feature that allows the user to see how each task fits into the AFMC core processes also is included. Another powerful enhancement provides a direct link between the AFAM tasks and the associated reference documents in the AFAMSUP. This allows the user to instantly access direct information applicable to each task.

Colonel Mike Ferrell, AFAM program director stated, "A tremendous amount of effort has been put into this release in response to our customers' requirements. I think our customers are going to be delighted with this product because it offers them more flexibility and a wider range of information. Take a look at AFAM 2.0 for yourself and let us know what you think."

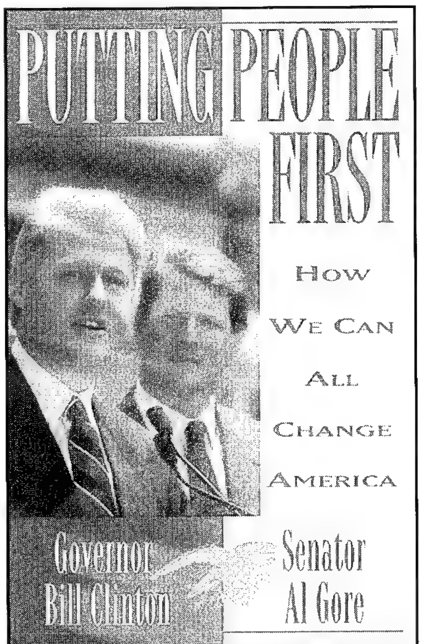
For information on how to obtain a copy of the system, telephone the AFAM Program Office at DSN 785-0416 or (513) 255-0416.

NOTIONS FOR AN ALTERNATE SYSTEM

BETTER MANAGEMENT WITH FEWER PEOPLE

Acquisition Reform and the Civilian Workforce

Vicky R. Armbruster



"We must reward the people and ideas that work and get rid of those that don't."

The call for defense acquisition reform has been heard. Congress is examining a broad assortment of specific recommendations for change in existing law. Actions to date, however, have focused largely on the body of law, policy, regulation and procedure associated with the defense procurement process, and have paid scant attention to managing the human resources required to execute the process.

The civilian acquisition workforce struggles daily to satisfy the needs of America's armed forces within a work environment burdened by bureaucracy, highly controlled by federal law and regulation, awash in paperwork and faced with the certainty of restructuring and downsizing actions. Can acquisition reform realize the desired outcome, as stated in the Report to Congress of the DoD Acquisition Law Advisory Panel, of providing better management with fewer people at less cost without addressing the human resources dimension of the acquisition system?

The Climate of Change

The vision and framework for improving the acquisition workforce are in place. The Defense Acquisition Workforce Improvement Act (DAWIA) of 1991 (Public Law 101-510) set the stage for the Services to establish professional corps of civilian and military acquisition personnel. For example, the Army Acquisition Executive Support Activity has established the following statement of purpose to describe the Army Acquisition Corps:

"We seek to establish a world-class acquisition workforce [made up of] bold, innovative acquisition professionals; people with keen business sense, technical competence and strong desire to tackle complex projects; [and] leaders and managers who are dedicated to providing our soldiers with world-class equipment."

If workforce quality is a priority, the personnel management system must recognize and promote these desirable qualities in meaningful ways. How can the Services establish and maintain a high performance workforce in a period of restructure and downsizing, given a personnel management system which ensures job security to average performers and gives highest value to seniority and service time in the event of reductions in force?

Few in government would disagree that there is fat and waste to be trimmed, given the opportunity to redesign the acquisition organization. Care must be taken, however, that any new structure be viable, represent a requirements-driven organizational design, and be populated with a workforce reflecting diversity in experience, occupation, grade, age, gender and minorities.

In addition to the acquisition reform initiatives, other forces for change exist in acquisition personnel management. Vice President Gore's Report of the National Performance Review (NPR) deals, in part, with federal government organizational design, ad-

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Ms. Armbruster is Deputy Project Manager, Air-to-Ground Missile Systems Project Office, Redstone Arsenal, Ala. She is a PMC 94-1 graduate.

vocating more horizontal organizations, and imposing limits on the manager to subordinate ratio. More to the point, President Clinton and Vice President Gore coauthored the following opinion in their book, *Putting People First*: "We must reward the people and ideas that work and get rid of those that don't."

Composition of the national labor force is in transition with far more women and minorities, changing skills mix, and an aging population. The proportion of the population aged 50 and older will grow faster in the 1990s than any other group. In the context of a professional acquisition corps, this age group represents a highly capable, knowledgable core of experts and potential mentors who, given the current economic climate, may not only want to work longer, but may need to work longer to ensure financial independence in the face of diminishing real values of social security and retirement benefits. However, the acquisition personnel management system must be amended to require continuous education, retraining and redeployment of older workers to preclude potential homesteading and stagnation, which could lead to reduced effectiveness within the ranks of a professional acquisition corps.

The DAWIA has mandated minimum educational requirements for critical program management positions; however, the issue of proficiency training or reeducation to maintain up-to-date knowledge and skills also must be addressed. A variety of solutions are possible. Setting a minimum number of hours of documented training or education per year is an option. Another solution is to establish a cycle for reeducation; perhaps every four years (coincident with reassignment), a refresher course might be required.

Another force for change is the growing dependence upon matrix support to acquisition programs. The skills and abilities needed to integrate and motivate personnel from external organizations and manage multiple chains of command require a new breed of leaders. These master integrators, with all the problems and pressures they face, are not well served by the rigid, bureaucratic, inflexible management practices in place today.

Perhaps the strongest force for change is the growing similarity in work situation between the military and civilian components of the acquisition community. Previous distinctions in the areas of work assignment, mobility, performance standards, performance evaluation and, in some respects, training and education no longer exist. Furthermore, the fact that the Army intends to hold combined military and civilian program manager selection boards implies profound change for civilian acquisition personnel management.

A Workforce in Transition

Demands for a world-class acquisition workforce impose new standards of performance and new methods of management to permit recruitment, development and retention of the best and the brightest. Recruitment is almost nonexistent, and reassignments, while required under the Army Acquisition Corps accession agreement, take entirely too long in the rare cases where these actions are even possible due to local freeze policies. Some insight can be gained in this area by looking to industry where the competitive pressures have been intense since the mid-1980s with resultant restructuring and downsizing a common occurrence. Many corporations have not survived market pressures; others have changed and can be seen thriving in a business environment where opportunities are fewer. What made the difference?

Edward E. Lawler III, Susan G. Cohen and Lei Chang, writing for the Laborforce 2000 Survey, state that the factors serving to attract, motivate and retain today's employees include (in this order): (1) opportunities for interesting work; (2) compensation; (3) opportunities for advancement; (4) opportunities to participate in decisions; (5) health benefits; (6) job security; (7) retirement benefits; (8) family support policy; and (9) flexible work schedules.

While individual motivation factors are unique for each employee, the Laborforce 2000 statistics were

Photo by Richard Mattox

At a White House ceremony in September 1993, framed by the bulk of documents that define "red tape" of the federal bureaucracy, President Clinton acknowledged and accepted the National Performance Review presented by Vice President Gore.

collected across 406 randomly selected companies from the Conference Board, a business research consortium composed of firms strongly interested in data on economic and organizational trends. The indicators, therefore, serve to focus managerial attention on those needs most prevalent in the workforce. Whether this is the exhaustive list or not is less important here than the order of preference.

Federal personnel management system performance in the current environment is marginal in at least the top three priorities. Many defense agencies have been under hiring, promotion and transfer freeze policies for several years now, and civil service has not been competitive in compensation for a very long time.

Job security, on the other hand, popularly seen as the major advantage of government service over employment with industry, ranks sixth in priority for the employee population sampled. According to Mirvis, the notion of cradle-to-grave job security has been abandoned by the broad base of American industry.

The private sector has long recognized the advantages of professional development (fostering movement through a variety of assignments, thus answering the need for interesting work), has pay scales typically higher than their government counterparts, and rewards high achievers with advancement opportunities. Businesses are now concentrating on human resource development strategies such as mentoring, education and training, flexible schedules, retraining and reassignment, diversity programs, child and elder care assistance, and phased retirement options.

On the other hand, the defense acquisition workforce leadership must yet reform its personnel management system to create a work environment attractive to the quality professionals required by the Congress, the White House and the DoD. Such a system, in order to keep quality personnel, must be designed to satisfy workers' high-priority needs.

The DAWIA has mandated minimum educational requirements for critical program management positions; however, the issue of proficiency training or reeducation to maintain up-to-date knowledge and skills also must be addressed.

The Clinton administration is actively involved in an effort to "reinvent government." The NPR made recommendations for profound change in government workforce management. Among the specific provisions, the report recommends phasing out the *Federal Personnel Manual* and all agency implementing directives, decentralizing personnel management authority, creating demonstration projects to permit agencies greater flexibility to hire, retain and promote the best people they find, as well as allowing pay scales to be pegged at market rates.

Though the NPR does not establish policy or mandate action, it does serve to emphasize administration initiatives, some of which (such as the Government Performance and Results Act) are already codified in law. While these activities can be expected to yield results in the future, defense acquisition is already in the throes of change. The Secretary of Defense has further enabled action toward NPR goals by delegating authority to the Secretaries of the military departments and Directors of defense agencies to waive DoD directives, publications and instructions as needed to streamline or reengineer processes.

Personnel Management Environment

The civilian personnel management system in place for acquisition personnel is the Competitive Service. Provisions exist under Title 10 for exceptions to be made to the broad application of Competitive Service. This form of employment is known as Excepted Service.

Excepted Service is fundamentally different from Competitive Service in the areas of appointments, assignment changes, terminations and removal actions. The appointment process for Excepted Service is simplified; movement between the Excepted Service and Competitive Service is enabled through agreement between the federal agency and the Office of Personnel Management (OPM); and terminations and removal actions are simplified while still providing for an appeals process.

Excepted Service is utilized by all three branches of government. The Legislative Branch has a variety of excepted categories including positions in the General Accounting Office and Library of Congress. The Judicial Branch has a similar arrangement, excluding the Administrative Office of the U.S. Courts. Within the Executive Branch, Title 5 U.S. Code lists the following categories of positions as excepted:

a. Positions excepted by statute, such as intelligence-related positions

(e.g., DoD, DIA, CIA, FBI, NSA), the Tennessee Valley Authority, the Foreign Service, the Nuclear Regulatory Commission, the United States Postal Service, and physicians, dentists, nurses and allied health positions.

b. Positions excepted by presidential executive order in the interest of good administration as provided for in Title 10 U.S. Code, Section 3302. This includes certain positions in the Departments of Interior, Health and Human Services and Commerce, the Environmental Protection Agency, and others.

c. Positions excepted by the OPM.

Several categories of defense personnel are employed under Excepted Service; these include, but are not limited to, academic staff, political appointees, and a broad range of intelligence-related personnel.

Given the importance of the defense industrial base to national economic security and the unique human resource requirements of DoD acquisition, consideration must be given to converting the defense civilian acquisition workforce to the Excepted Service and establishing a separate personnel management system, referred to here as the Civilian Acquisition Personnel Management System (CAPMS), to manage more professionally this segment of the government workforce.

Existing Alternate Personnel Management Systems: the DSMC and CIPMS Approaches

Among the diverse organizations operating under Excepted Service rules, a broad range of management schemes exists. Some are generally similar to the Competitive Service, and others are almost unrecognizable as government personnel management structures.

An example of a truly revolutionary approach is the structure adopted by the Defense Systems Management College (DSMC) faculty. In this example, the GS/GM position rating, job descriptions, job performance standards and performance appraisals have been discarded. A unique ranking system has been devised which ties faculty basic pay to private sector rates. Routine annual recommendations for pay increases are based on value added factors such as increased capabilities, sustained contributions, demonstrated ability to assume greater responsibility, and added experience. This model is being applied to a small, highly skilled and homogeneous sector of defense acquisition educators.

A more traditional example, and perhaps a more appropriate model for the civilian defense acquisition population, can be found in the Critical Intelligence Personnel Management System (CIPMS), which established a common tri-Service framework for managing defense intelligence personnel from a variety of occupation categories.

The intended purposes of CIPMS respond to the same needs as those facing defense acquisition today. Specifically, CIPMS offers flexibility and responsiveness to changing requirements, comparability for similar personnel, professional development, timely adjustments in workforce composition in response to current workload pressures, and the incentives necessary to recruit and keep quality personnel.

The origin of CIPMS can be traced to Title 10 U.S. Code, Section 1590. The law specifically states that the Secretary of Defense "...may, without regard to the provisions of any other law relating to the number, classification, or compensation of employees

1. establish such positions for civilian intelligence officers and employees of the military departments as may be necessary to carry out the intelligence functions of such departments;
2. appoint individuals to such positions; and
3. fix the compensation of such individuals for service in such positions."

As in the DSMC example, CIPMS is exempt from the Classification Act of 1949 and, thus, from OPM oversight and authority in classification matters.

The CIPMS management system is designed to accommodate a broad range of occupation categories and relies on established position descriptions, performance standards and appraisal procedures. It differs from the Competitive Service, however, in enhanced responsiveness to changing conditions. The CIPMS enables compensation practices which explore the full range of basic pay, recruitment and retention incentives, and performance recognition financial rewards.

A provision for special salary rates exists, also, which can be established based on rates of pay for comparable work in the local area. Still another incentive is available within CIPMS to encourage mobility and that provides for a maximum two-step pay increase upon reassignment to a different position at the same grade level currently held. While CIPMS restricts this type of incentive to reassignments outside the geographic area, acquisition leadership may determine that this type of incentive is appropriate to motivate talented professionals to leave positions which they otherwise would have preferred to retain.

A special performance award has been identified within CIPMS which recognizes exceptional performance for at least three consecutive years. This award results in an increase in basic pay equivalent to two quality steps.

The CIPMS system advocates delegation of authority for personnel management decisions to line man-

agers, thus placing the budgetary and execution responsibilities for personnel related expenses at the level closest to personnel doing the actual work. The likelihood that appropriate levels of salary, benefits, recruitment and retention incentives, awards and training opportunities will occur is thus higher.

Minimum time-in-grade promotion restrictions which are standard for OPM do not apply to CIPMS. Likewise, there are no guaranteed or implied intervals for promotion. The spirit and intent of merit principles govern promotions.

In addition to financial incentives, alternate forms of reward are available under CIPMS. These include honorary awards and a variety of special awards. Worker satisfaction can be profoundly influenced by public recognition of achievement or distinction. A variety of citations, service medals, and certificates of accomplishment for extraordinary efforts in acquisition management could go a long way to energize and inspire the workforce to excel.

The CIPMS also imposes a set of conditions of employment which must be communicated in a written agreement with applicants and employees. For the intelligence personnel example described here, the requirements include level of clearance, periodic polygraph, physical and medical standards, and mobility.

In the acquisition field, certainly a condition of employment should be mobility (both geographic and interdisciplinary). Requirements for continuous education and training could also be conditions of employment.

Furthermore, a critical flaw within Army civilian acquisition personnel management which must yet be addressed is the very real problem of a professional acquisition corps that is effectively filled to capacity. While no firm cap has been imposed, budget pressures demand an upper bound for membership. In fact, the Army Acquisition Corps has been closed to new applicants since 1992.

> **Among the diverse organizations operating under Excepted Service rules, a broad range of management schemes exists. Some are generally similar to the Competitive Service, and others are almost unrecognizable as government personnel management structures.**

What action can be taken to winnow the population on an as-required basis to make room for appropriate levels of new or junior personnel to enter? Unless action is taken, a static workforce will evolve which continues to age until large-scale retirements begin to occur. At that future time, few seasoned junior professionals will be available to assign to critical vacancies.

Therefore, some provision must be made for a civilian selective retirement/reassignment board to carry out the onerous task of identifying personnel excess to the corps needs.

Maximum consideration should be given to reassigning released employees to vacant positions (in either Excepted or Competitive Service) within their chosen geographical region. In this case, another similarity would be created with the military component of the acquisition corps. These officers have already been subjected to a series of Selective Early Retirement Boards which would provide practical lessons learned for application to the civilian situation. Acceptance of this process is another potential condition of accession to the acquisition corps, and could be delineated in a written agreement similar to that used by CIPMS.

Notions for an Alternate Acquisition Personnel Management System

Profound change is the order of the day for defense acquisition. Workforce reform must be addressed in an environment of downsizing or "rightsizing" of civilian personnel. If shrinkage takes place in the near-term, within the rule sets that exist today for Competitive Service, many of the best and brightest acquisition professionals will be lost, while some persons with less skill but greater seniority will be retained. Furthermore, little opportunity exists today to invigorate the workforce through recruitment of new talent or through personnel movement between existing organizations.

A way must be found to recruit, develop and assign high-quality acquisition professionals to challenging programs, and then retrain, reeducate, redeploy and ultimately release these personnel as the situation warrants. It may even be time to relook at the population of experienced, acquisition qualified, retired military officers. This group represents a valuable pool of talent that is now discouraged from joining government service since their earned retirement income would

be reduced significantly. The Services are, therefore, losing their long-term investment in these acquisition experts to industry.

An alternate civilian acquisition personnel management system such as CAPMS would respond to the forces for change affecting defense acquisition today. The CAPMS, with features tailored from the CIPMS model, would remove many of the existing barriers to effective performance by this uniquely skilled and increasingly important segment of the national workforce. This proposed new personnel management system should be structured to respond to the priority needs of the contemporary American workforce.

In addition, CAPMS should offer enhanced mentoring opportunities, require periodic education and training, encourage interdisciplinary and organizational mobility, provide mandatory diversity programs, ensure reassignment flexibility to return to the Competitive Service, and allow for phased retirement options. The CAPMS should incentivize recruitment of key personnel, reward outstanding performers in a variety of ways, and provide a process for adjusting the size and composition of the acquisition workforce to match workload demands.

The proposed CAPMS management system responds fully to the NPR recommendations and is executable today under existing law. Action to implement the alternate management structure can be taken by presidential executive order in the interest of good administration or by OPM action in accordance with Title 5 U.S. Code, Section 3302. An opportunity also exists to create a demonstration or pilot project to permit evaluation and detailed definition of this alternate approach to acquisition personnel management.

Conclusion

Experts from the American business community predict the future will exert even greater demands on the workforce than the present. J. Boyett and H. Conn, in *Workplace 2000: The Revolution Shaping American Business*, state, "There will be even fewer resources than there are now — less time, less money, fewer managers and supervisors to make the decisions, less opportunity to make mistakes, less job security."

> "There will be even fewer resources than there are now — less time, less money, fewer managers and supervisors to make the decisions, less opportunity to make mistakes, less job security."

Given this environment and the pressures from the White House and Congress as well as from within the Department of Defense, civil service can no longer remain immune to change. Like our partners in defense industry, we in government must find creative ways to ensure that our armed forces remain equipped with high-performance materiel at a cost the nation is willing to pay.

Recognizing the importance of the defense industrial base to U.S. economic security, the call for defense acquisition workforce improvement, and the certainty of reduced effectiveness due to downsizing actions, acquisition leadership should consider converting civilian defense acquisition personnel to the Excepted Service and establish a separate personnel management system to meet the urgent challenges facing this critical component of the national workforce.

References

Boyett, J. and Conn, H. (1991). *Workplace 2000: The Revolution Reshaping American Business*. New York: Dutton Books, 327.

Clinton, B., and Gore, A., Jr., (1992). *Putting People First*. New York: Times Books, 23-24.

Department of the Army Regulation 690-13.

Department of Defense Directive 1400.34.

Department of Defense Manual 1400.34-M.

Department of Defense (1992, November). "Civilian Faculty Plan," Paper. Defense Systems Management College.

Department of Defense (1993, March). *Streamlining Defense Acquisition Laws - Executive Summary: Report of the DoD Acquisition Law Advisory Panel to the U.S. Congress*, Defense Systems Management College.

Federal Personnel Manual. Chapter 212, par. 3-1.

Ibid, Chapter 315-6.

Gore, A., Jr., VP. (1993). "Creating a Government that Works Better and Costs Less," Report of the National Performance Review, 20-25.

Grube, R., COL, USA. (1994, January). "Army Acquisition Corps Career Management," Briefing at the Defense Systems Management College, Ft. Belvoir, VA.

Mirvis, P. H., Ed. (1993). *Building the Competitive Workforce*. New York: John Wiley & Sons, Inc., 55.

Ibid, 29.

Secretary of Defense, (28 March 1994), Memorandum, Subject: Waiver Authority.

Section 1202, Public Law 101-510, "Defense Acquisition Workforce Improvement Act."

5 U.S.C. 3301 and 3302.

10 U.S.C. 1590.

DEPARTMENT OF DEFENSE OPENS ACQUISITION HISTORICAL CENTER

Acting Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) R. Noel Longuemare has announced that the Department of Defense (DoD) Acquisition Historical Center is officially open for business, and is ready to receive donations and researchers.

The Center is located in the Acker Library on the campus of the Defense Systems Management College (DSMC), Fort Belvoir, Va., and is open on Mondays and Tuesdays from 8 a.m. to 5 p.m.

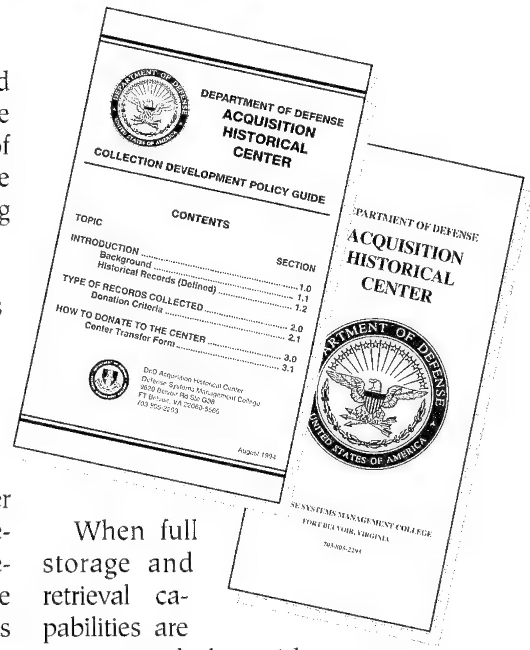
"The need for such a repository has been known for a long time in DoD. I strongly encourage all defense acquisition officials to donate information to the Center and take advantage of its facilities for acquisition research," said Longuemare.

To fill the void as the only central repository of acquisition information in DoD, the Under Secretary of Defense (Acquisition) began the project to establish the Center at DSMC in 1992. The Center collects, stores and makes available for retrieval acquisition information in various media.

The Center serves donors and researchers from DoD, other government organizations, academe, Congress, the media and the public. A contractor team of Arist Corporation, Alexandria, Va., and History Associates, Inc., Rockville, Md., operates the Center. The team is developing a prototype electronic database of finding aids to provide on-line service via the Defense Data Network and Internet. Information from the Office of the Deputy Under Secretary of Defense (Acquisition Reform) and the Naval Air Systems Command is being used in developing the prototype.

The Center collects lessons learned, acquisition program office files, studies and reports, briefing and issue papers, case studies, symposia proceedings, decision memoranda and other associated information. For example, the Center has received records of former Defense Secretary Dick Cheney's Defense Management Review; the F/A-18 program; the Defense Systems Acquisition Review Council, predecessor to the Defense Acquisition Board; and the former Office of the Secretary of Defense Office of Acquisition Policy and Program Integration. Also collected are lessons learned from the Mobile Subscriber Equipment program and histories of the Air Force Operational Test and Evaluation Center.

Donations by acquisition officials are voluntary. Only copies are collected. Unclassified information donated is considered to be nonsensitive and "publicly releasable," or to meet one of the nine exemptions under the Freedom of Information Act. The Center does not collect material containing proprietary, top secret, nuclear weapons, or commercially printed information, information deemed sensitive to the originator or donor, or duplicate information collected by the Defense Technical Information Center.



When full storage and retrieval capabilities are operational, by mid-1996, much of the classified information will be available through full-text retrieval allowing workstation printing. Classified information is available on-site through prior arrangement. By 1997, the Center will provide a nationwide clearinghouse database to identify in what government and nongovernment repositories items of acquisition information are held.

Copies of the collection and user policies are available on request from Center Director Wilbur D. Jones, Jr., DSMC Associate Dean of Information. The address is DEFENSE SYST MGMT COLG, ATTN DIR ACQ HIST CTR, 9820 BELVOIR ROAD, SUITE G38, FT BELVOIR VA 22060-5565. Jones can be contacted at (703) 805-2525 (DSN 655-2525), Fax (703) 805-3856. He is assisted by Jane Cohen, DSMC Reference Librarian, at (703) 805-2293 (DSN 655-2293).

MUST BOTTLENECKS IN THE SOFTWARE PROCESS BE FEARED?

Paradigm Shifts Are Uncomfortable

Lt Col Joe G. Baker, USAF

The books *The Goal* and *The Race* stem from the Theory of Constraints concept. *The Goal* is written as fiction with the main characters using this concept to solve a series of manufacturing problems. *The Race* is a follow-on book, but is more "how to" in presenting the Theory of Constraints concept.

Memories surfaced after I read these books. Just pictures from the past, but these flashbacks took on new and disappointing meanings. Disappointment came as I began to realize that the Configuration Control Board (CCB) meetings I chaired and the software development division I directed were not maximizing the resources available anywhere close to the level they could achieve.

I did not understand "bottlenecks," constraints or, according to *The Race*, "capacity constraint resources." I know the definition of a bottleneck, but I did not know what the real bottleneck was in the software development process I sought to control as the Chief of Software Development and the CCB chairperson. This was a small software activity of about 10 government and 20 contract programmers who maintained the application code on an IBM mainframe. The atmosphere in this environment was casual. Individuals were trusted to do the job, and this was good. Management opinion of workload was subjective, and this was bad.

Before the CCB, the functional users would rank, in order, the Problem Reports and new requirements. Our programmers reviewed this list, met with the users, and determined what could be done in the next release. Most applications were stovepiped with one or two programmers per application. I moved our organization into this process so the CCB meetings would not encompass one whole day and accomplish only the official approval of the contents of a release. During the CCB, I asked each lead programmer what he or she could accomplish. The functional users then openly agreed and the meeting ended. Though the meeting was short, decisions were made and output was maximized. Most CCB attendees appreciated this process change.

After following this process so far, do you perceive what others and I considered the constraint in our software process? The programmers were viewed as the constraint or bottleneck. Some of you may be curious about the testing resources. When we developed our release schedule, we blocked off time for testing. From experience, we automatically set aside a certain number of weeks per release. Our software process assumed the test time set aside for each software release was adequate. I should have invested a little time into the activities conducted during our test time and, thus, possibly increased the number of changes we included in each release. It was now too late. What I once viewed with some pride and satisfaction took on new emotions. Paradigm shifts are not painless.

Problems Provide Opportunities

My point is that for every problem there is an opportunity. For example, the opportunity to improve the capacity and speed of software delivery exists. This may sound like I'm writing about manufacturing instead of software development or software maintenance; but, in some ways "software manufacturing" may be a more appropriate paradigm.

A bottleneck is an opportunity to know how many software changes you can insert per release, and the opportunity to control and maximize throughput through each component of your process. For example, when you attend a crowded music or sport-

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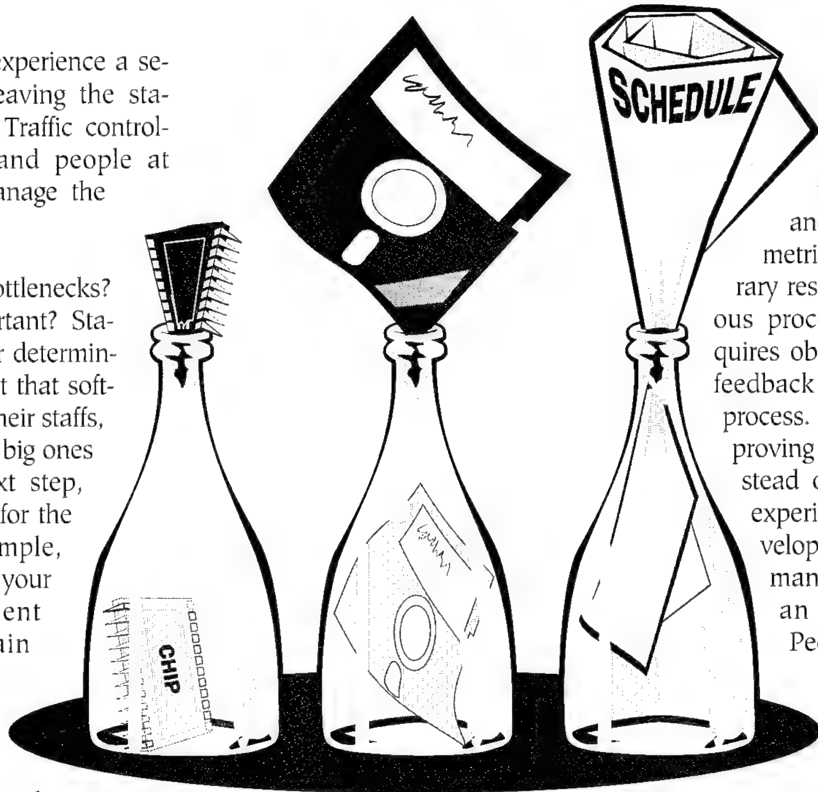
ing event, don't you experience a series of bottlenecks leaving the stadium or parking lot? Traffic controllers erect barriers, and people at strategic locations manage the crowd.

Where are your bottlenecks? Which is most important? Statistical means exist for determining these, but I submit that software managers, with their staffs, probably can pick the big ones out subjectively. Next step, determine the reason for the bottleneck. For example, suppose you selected your software development system as the main bottleneck. Is the solution to buy another? Stop and think. Why is it your constraint? Does it need additional memory or an upgraded operating system? Do you need to juggle schedules to add another shift during peak times. Before you spend heavily on new equipment, ask yourself how you are utilizing your time on different components of this system. You may need to break off a part or buy a subset of the system on which to do your prototyping or unit testing.

I was fortunate to be associated with a project where individuals sought to maximize throughput as each bottleneck was encountered. Briefly, they costed each change after determining the requirements by discipline such as programming, building, integration, testing and documentation. Since building each release through the build shop was time-consuming, they grouped changes together that used the same software modules. This reduced compilation time by the build shop, and shortened the time the integrators used on the system to check out the new code.

When the testers did their formal testing, their standard tests encompassed several changes with one test, reducing the time spent using the critical system. As you might guess, as soon as one bottleneck was eliminated another surfaced. However, they worked these also. Ultimately, they could identify potential new bottlenecks before they eliminated an old one. This began to influence their solutions to the original constraint. *The Goal* and *The Race* go into more detail about constraints.



Identifying and manipulating your bottlenecks should help you sleep at night. Then again, you may lie awake thinking about them.

Conclusions

To improve your throughput, you can hold meetings, announce goals, and produce impressive metrics to achieve temporary results. Serious, continuous process improvement requires obtaining good, ongoing feedback and monitoring the process. The difference is improving throughput once instead of continually. In my experience, a software development, maintenance or manufacturing project is an evolving process. People, technology and requirements change yearly. In some organizations, changes occur monthly. Unless you can see and understand your bottlenecks, how can you adjust schedules and resources effectively? You are bound to the person who for that month seems to have the right answers. In the next month, the knowledgeable person is wrong because his or her subjective opinion is not based upon fact.

For the sake of credibility, I will avoid postulating a maxim that controlling bottlenecks will solve all or most problems. From my experience, the source of anxiety will be removed as you begin to get a firm grip on your process. Identifying and manipulating your bottlenecks should help you sleep at night. Then again, you may lie awake thinking about them.

References

1. Goldratt, Eliyahu M., and Cox, Jeff. *The Goal: A Process of Ongoing Improvement*, North River Press, Inc., Croton-on-Hudson, New York, 1986.

2. Goldratt, Eliyahu M., Robert E. Fox, *The Race*, North River Press, Inc., Croton-on-Hudson, New York, 1986.

DSMC GUIDEBOOKS NOW AVAILABLE

NEW INTEGRATED LOGISTICS SUPPORT GUIDE

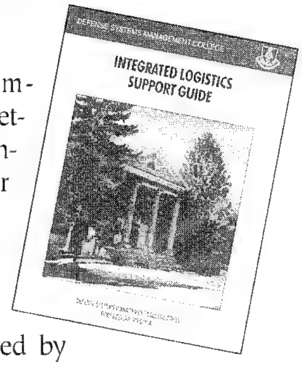
The second edition of the *Integrated Logistics Support* (ILS) Guide, published by the Defense Systems Management College (DSMC Press), is now available. This Guide supersedes the 1986 edition . It was revised and updated to reflect the latest Department of Defense (DoD) acquisition logistics policies.

A new section was added on the Continuous Acquisition and Life-Cycle Support (CALS) initiative to generate, exchange, manxage and use digital data to support defense systems. Professor Stan J. Crognale, Funds Management Department, DSMC, authored this chapter. Mr. Crognale has worked closely with the Office of the Secretary of Defense CALS Office to help make CALS a reality and to educate managers on its potential.

The second edition was designed to be a general road map for newcomers to the acquisition logistics management career field, and to serve as an overall study aid for acquisition managers who work with acquisition logistics managers. The Guide is divided into the five modules shown below:

"Introduction to ILS": Introduces the ILS process and its objectives, ILS planning requirements, development of readiness and supportability objectives and design parameters.

"Developing the ILS Program": Describes the ILS impact on design and logistic support requirements; the integration of readiness, supportability and life-cycle cost into the ILS process; Logistic Support Analysis and its documentation; and test and evaluation procedures that ensure the adequacy of planned ILS capabilities.



"Programming, Budgeting and Contracting for ILS" in Module III addresses the special skills required by the ILS manager.

"Providing the Support": Focuses on the ILS role in planning for and accomplishing production, deployment, operational and post-production support.

"International, Nonmajor, and Joint Programs": Presents the differences in ILS management for international, nonmajor, and joint-Service programs.

Ordering information is detailed below. Be sure to include the correct stock number and payment, as appropriate, with your order.

Many DSMC faculty and staff have contributed invaluable assistance in the revision of the ILS Guide. The DSMC Press expresses a hearty thanks to them and good reading to you.

SCHEDULING GUIDE FOR PROGRAM MANAGERS

The Defense Systems Manage ment College (DSMC) Press recently published a revised edition of the popular *Scheduling Guide for Program Managers*. The guidebook was authored by William Bahnmaier, Professor of Acquisition Management, DSMC.

This May 1994 revision is designed to provide the program manager and program management personnel with an understanding of, and a basic working familiarity with, the newest and most effective scheduling methods used in defense systems acquisition. It is particularly useful in the planning and controlling for all phases of a defense acquisition program.

Of particular significance, is the updated chapter on automated scheduling tools that Professor Bahnmaier included to reflect the latest computer software available.

Ordering information is detailed below. Be sure to include the correct stock number and payment, as appropriate, with your order.

The guidebooks are available at no cost to government personnel by writing or faxing a written request, on official stationery, to DEFENSE SYST MGMT COLG, ATTN OS-PR, 9820 BELVOIR RD, SUITE G38, FT BELVOIR VA 22060-5565, (703) 805-3857.

Nongovernment personnel may purchase the guidebooks by writing to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20204. Mastercard and VISA orders may be placed by calling (202) 783-3238.

For prompt processing, please include the appropriate stock number/payment with your order as follows:

Scheduling Guide for Program Managers, stock number 008-020-01333-1; cost is $4.25;

Integrated Logistics Support Guide, stock number 008-020-01330-7; cost is $16.00.

THE JOINT ADVANCED STRIKE TECHNOLOGY (JAST) PROGRAM

Streamlined Acquisition and Paperless Proposal Evaluation Process

David S. Hersh

This article describes the Joint Advanced Strike Technology (JAST) Program use of streamlined acquisition and a paperless proposal evaluation process to execute its first competitive procurement. It demonstrates streamlined acquisition and paperless procurement in action and shows that innovative methods can be applied successfully to make acquisition more efficient, to the mutual benefit of government and industry.

On 19 January 1994, the JAST Program brought together a joint-Service integrated product team (IPT) to prepare documentation for an open, competitive solicitation. On 6 May 1994, a scant 15 weeks later, the JAST Program competitively awarded 12 concept exploration study contracts from among the 154 proposals received. Before beginning the discussion of how this was accomplished, let me introduce the JAST Program and explain some of its objectives.

The Program and Its Objectives

The JAST Program was spawned by the Bottom Up Review (BUR). Somewhat like the Phoenix, JAST rose from the ashes of the AFX and MRF Programs and the decision to discontinue F-16 production. When the BUR canceled these programs, it created the JAST Program to deal with the capabilities shortfall the Services would experience when existing strike aircraft aged out of inventory. The vision of the JAST Program is a joint-Services team creating the building blocks for affordable, successful development of next-generation strike weapon systems.

The JAST is a new way of doing business. For the first time it brings together operators, technologists and developers on a single joint-Service team with a shared purpose. The team mission is to identify, mature and demonstrate technologies and concepts which meet warfighter needs, while reducing the cost of future joint strike warfare weapon systems.

As the name suggests, JAST is staffed by a joint-Service team consisting of Navy, Air Force and Marine Corps military and civilian personnel. There is no Executive Service responsible for managing the JAST Program, and JAST does not report to the Department of Defense (DoD). The program stands on its own with support from the three Services. The Program Director, Maj Gen (Sel) George K. Muellner, USAF, reports to the Navy Acquisition Executive. When the General's Deputy, RADM Craig Steidle, USN, takes over in two or three years, he will report to the Air Force Acquisition Executive.

The JAST Program is not one of technology development nor acquisition. It is the link, often missing, between science and technology programs and engineering and manufacturing development (E&MD). In carrying out its mission, JAST works with the research community and helps them focus investments. But JAST does not invest in, or manage, research. Likewise, JAST will not be responsible for E&MD.

Working with the Services, JAST will help their operational requirements staffs develop and validate operational requirements and will pass mature technologies and proven concepts to the Services for development.

Because many Navy, Air Force and Marine Corps tactical aircraft will reach the end of their service lives early in the 21st century, a high priority of the JAST Program is to mature technologies and demonstrate advanced tactical aircraft concepts for

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transition into development in time to achieve initial operational capability circa 2010. This means the transition to development must occur around the year 2000.

Lastly, as the model for this new way of doing business, JAST was tasked by Dr. John M. Deutch, then Under Secretary of Defense (Acquisition and Technology) to help lead the way in implementing paperless processes and using streamlined acquisition methods.

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Streamlining Actions

Streamlining of this contract activity was more than just an experiment for JAST, it was essential. With a need to transition demonstrated tactical aircraft concepts and mature technologies into development circa 2000, the JAST Program could not afford delays in establishing contracts with industry.

Three streamlining actions were taken: use of a broad agency announcement (BAA) for the solicitation, paperless proposal evaluation, and use of a Short Form Research Contract. Each of these actions will be described, but since two of these, the BAA and the Short Form Research Contract, cannot be used to contract for development and production of hardware and software, emphasis will be on the paperless proposal evaluation process. This can be applied to improve the efficiency of all procurements.

— *Broad Agency Announcement.* The JAST Program elected to use a BAA for this procurement because it provided an almost perfect match with two important program objectives — use of streamlined acquisition and the desire to obtain a range of innovative ideas.

The purpose of the BAA was early initiation of industry studies focused on identifying innovative concepts and technologies which could contribute to reduced cost for joint strike warfare. The BAA was drafted by an IPT consisting of personnel from the JAST Program, Naval Air Systems Command (NAVAIR), Wright Laboratories, and the Aeronautical Systems Center.

Use of BAAs is permitted under provisions of the Federal Acquisition Regulation (FAR) 35.001. Many requirements of a traditional Request For Proposal (RFP) are not relevant to a BAA. The BAA process is exceptionally straightforward. The solicitation, in its entirety (RFP equivalent), was published in *Commerce Business Daily* (*CBD*).

Offerors submit proposals based on the *CBD*, and contracts are awarded solely on the merit of each individual proposal based on "peer" evaluation. Discussions with offerors are permitted to clarify and refine proposals to better meet the needs of the government. Multiple contracts, or no contracts, may be awarded.

The BAAs are permitted when the intent of the procurement is: scientific study to advance the state-of-the-art, to increase knowledge/understanding when reasonable proposals are anticipated, when a conventional Statement of Work would stifle ideas and concepts, and/or when a "normal" (RFP) solicitation would unintentionally omit a viable source.

The BAAs may be used to solicit proposals for basic or applied research, to identify improvements in technology, materials, processes, methods, devices; or to attempt to advance the state-of-the-art.

A BAA should state needs in the most basic form, cannot restrict any approach, and should not segment or scope the work. The BAAs cannot be related to development of a specific system or hardware solution. Consequently BAAs are seldom used by development agencies. Program Research and Development Agreements (PRDAs), which are similar, are used frequently by Air Force laboratories, for purposes analogous to this BAA.

The first meeting to begin drafting the BAA was held on 19 January 1994. The BAA was published in the *CBD* on 17 February 1994, and 154 proposals were received by 15 April 1994. Compare this to the time normally required to draft and release an RFP and receive proposals, and one of the many benefits of using a BAA to streamline acquisition becomes apparent. Use of a BAA or PRDA should be considered whenever the above criteria pertain.

— *Short Form Research Contract.* Before proceeding to the main thrust of this article, paperless proposal evaluation, addressing the Short Form

Research Contracts used for the 12 contracts awarded is appropriate.

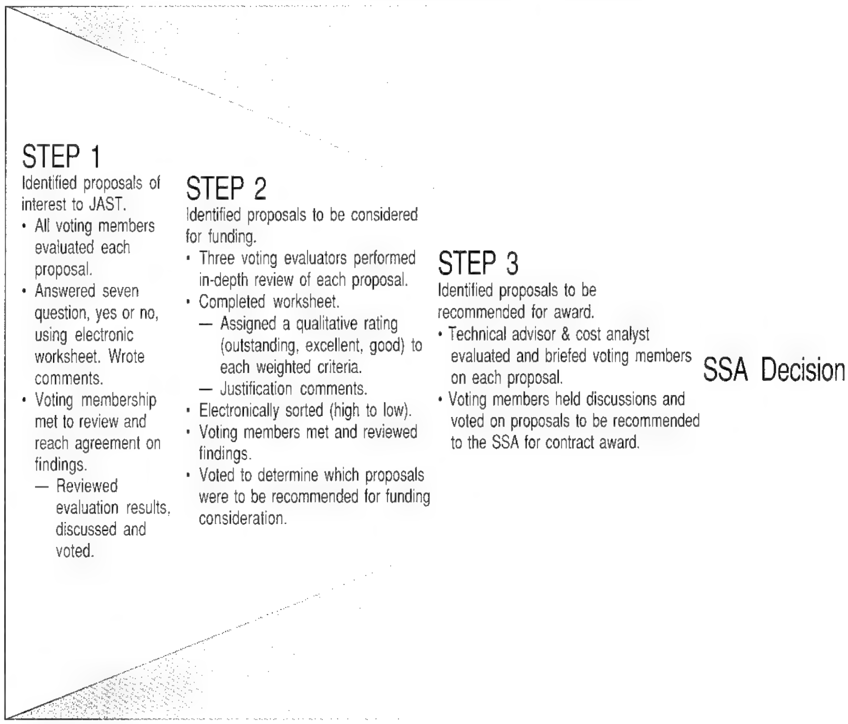
Short Form Research Contracts are greatly abbreviated contracts permitted under DFARS 235.015-71 (c) (2) (i), if the principal purpose of an acquisition is research from an educational institution or a nonprofit organization. As contracting agency supporting JAST in execution of this procurement, on behalf of JAST, the Naval Air Systems Command requested a Class Deviation to the Defense Acquisition Regulations to permit use of the Short Form Research Contracts. The deviation was endorsed by the Office of the Assistant Secretary of the Navy (Research, Development and Acquisition) and approved by the DoD, Defense Acquisition Regulation (DAR) Council.

Use of Short Form Research Contracts reduced the length of each contract awarded from approximately 100 pages, to about 12 pages. Actual length of each contract varied, because of the length of the Statement of Work.

Several benefits were derived from use of the Short Form Research Contract. Because the length of the contract was reduced substantially, fast completion of the contract negotiation and award process was possible. Less than a week was required to award 12 contracts. The Short Form Research Contracts are clear, concise and easier to understand; thus, manpower assets required for administration, management and execution of the contracts is reduced, to the mutual benefit of government and industry.

The Short Form Research Contract is not a panacea for all contracting requirements. Clearly, a research, development, test and evaluation contract requiring fabrication and test of hardware, or a hardware production contract, will require more substance. However, it does illustrate that substantial reductions in contract magnitude are achievable.

FIGURE 1. The Step Evaluation Process



— *Paperless Proposal Evaluation.* In a 24 January 1994 meeting, Maj Gen (Sel) Muellner decided to use paperless processes to execute the JAST Program BAA. Specifically, proposals were to be submitted electronically, the source selection accomplished without the use of paper, and all contract deliverables (studies) provided electronically.

To demonstrate his committment, Maj Gen (Sel) Muellner told the chief executive officers of 50 of the largest defense companies in the nation, at a briefing, that JAST would use these paperless processes. Also attending the briefing in which the General made this announcement was Dr. Deutch (USD(A&T), now Deputy Secretary of Defense), Mr. R. Noel Longuemare (now acting USD(A&T)), and Ms. Nora Slatkin (Navy Acquisition Executive). Maj Gen (Sel) Muellner reaffirmed this commitment before 207 industry representatives at the JAST Industry Day presentation held 25 February at DSMC. There was no backing down; credibility of the JAST Program was at stake. Few, believed that JAST could execute this paperless process to the General's incredibly challenging schedule — two weeks for proposal evaluation and one week for contract award.

How did the JAST Program meet this challenge? At the time of the decision to go paperless, there was no plan, no hardware and no software to do the job.

Following the decision to execute the BAA paperless, a broad search was initiated to identify experienced personnel, processes and tools to support achieving this objective. All leads were pursued. Discussions were held with personnel from the office of the Assistant Deputy Secretary of Defense (Acquisition Processes and Policies), responsible for DoD participation in the Electronic Commerce Initiative (ECI), the Defense Information Systems Agency, Navy procurement activities, Air Force procurement activities, the Defense Logistics Agency, and the Defense Systems Management College.

As a result of this search, it was determined that throughout DoD and

the U.S. Government there exists little useful experience and a lack of available tools for paperless contracting and proposal evaluation. While some work had been accomplished in this area, the tools used were not documented, and developers/users felt their software was not suitable for use by other programs, either due to lack of documentation or because the software was immature or had not been tailored to specific efforts.

The ECI is working toward implementing standards and tools for electronic contracting, but they are reported to be approximately two years away from implementation.

Inventing a New Approach

With no existing paperless contracting and proposal evaluation tools identified as available, the conclusion was that inventing a new system to meet the JAST requirements was necessary. The approach selected was designed for ease of use, high reliability, and the capability to accommodate and track the large number of proposals anticipated. The short time frame available for developing and implementing the system and conducting the evaluation were also important considerations.

Holding to the tenet that this initial attempt at paperless proposal evaluation should be kept simple, we only required contractor proposals on diskette. While direct electronic submission would be preferred, the judgment was that there were too many uncertainties and risks associated with attempting to accomplish this in the time available.

Direct electronic submission would have required resolving several challenging issues, including protecting classified and proprietary data, data integrity, legality of electronic signatures and data transmission standards. To avoid these issues, the procuring contracting officer concluded that a single original "paper" copy of each proposal would be required. This also provided a fallback in the event a proposal was not readable electronically.

A local area network (LAN), consisting of 12 personal computer workstations, was established to support the evaluation. All workstations were equipped with 21-inch monitors and appropriate operating and application software. Two workstations were positioned in a conference room to be used for group meetings and voting.

Either of these conference-room workstations could be selected to drive six additional monitors which operated as repeaters. These monitors allowed the voting evaluators to view proposals and review the results of each phase of the evaluation together. Computer video projection equipment was considered but rejected, because it could not be procured in the time available.

The electronic evaluation tools used were developed employing a powerful relational database application. Tools included worksheets, display screens, a summary screen, and an infinite variety of useful reports. The system provided significant benefits which contributed to an incredibly thorough and highly efficient evaluation.

Using the capabilities provided by this system, the head of the evaluation team (RADM Steidle) was able to assess instantly the progress of every evaluator. After every voting session, results were immediately available. Technical advisors and cost analysts did not have to prepare briefing charts. All of the information needed was available on the existing screens.

Likewise, the evaluation panel did not have to prepare materials to brief the Source Selection Authority (SSA) on their recommendations. The moment the SSA made decisions, the results were completely documented.

FIGURE 2. Evaluation Step One Summary Screen

Proposal #XXX Offeror Company Name
TITLE Title of Proposal as Identified by Offeror

SPONSOR NAME Company Name ADVISOR Name of Individual
COST $X,XXX,XXX; CATEGORY Proposal Category; e.g., off Board Sensors

SYNOPSIS

*	3 NAME	1	2	3	4	5	6	7	8
*	8 NAME	1	2	3	4	5	6	7	8
	10 NAME	1	2	3	4	5	6	7	8
*	7 NAME	1	2	3	4	5	6	7	8
	2 NAME	1	2	3	4	5	6	7	8
*	4 NAME	1	2	3	4	5	6	7	8
	5 NAME	1	2	3	4	5	6	7	8
	6 NAME	1	2	3	4	5	6	7	8
*	8 NAME	1	2	3	4	5	6	7	8
*	9 NAME	1	2	3	4	5	6	7	8

☐	Of Interest to JAST	Green	YES
☐	Interest with Corrections	Grey	NO
☐	Not of Interest	Clear	N/A

Use of passwords controlled access levels and provided data integrity. Tools available in the system facilitated preparation of post-evaluation letters to each offeror, and generated data needed to debrief offerors. The following discussion briefly describes the evaluation process and how the electronic tools were used. Additional information available from JAST is identified at the end of this article.

The three-step process used is depicted in Figure 1. The process was tailored to satisfy the unique characteristics of this solicitation, and efficiently neck down from the large number of proposals anticipated.

Using this and the electronic tools, each of the 10 voting evaluators read all 154 proposals, conducted an exceptionally comprehensive review, and quickly necked down to the 12 contracts awarded. The entire evaluation was accomplished in nine working days without a need for evaluators to work extended hours or weekends.

In accomplishing Step One, all evaluators read every proposal and recorded their evaluation by completing a user-friendly worksheet. Large monitors permitted simultaneous display of the worksheet and the proposal. Periodically, the evaluators gathered in the conference room, reviewed the results of their independent assessments, and voted.

The color-coded summary screen depicted in Figure 2. was used to support the voting. The screen identifies the offeror and includes other pertinent information. The screen also shows the individual color-coded response of each evaluator to questions, and their overall assessment. A simple tool, not depicted, permitted display of individual evaluator comments.

Step Two of the evaluation was conducted in a similar manner. However in this step, three evaluators representing the JAST Requirements Group (the war fighters), the Technology Maturation Group, and the Integration Group thoroughly reviewed each proposal forwarded from Step One and completed a qualitative assessment. To accomplish, this they reread each proposal brought forward and answered questions contained on the Step Two worksheet with a qualitative response (e.g., outstanding, excellent, good). They independently rated each proposal, but collaborated on a joint presentation of their assessment to the other members. A summary screen similar to Figure 2 was used to support the briefings. Following the presentation and associated discussion, the evaluation team members voted to determine which proposals should be brought forwarded to Step Three.

Step Three was used to identify proposals to be recommended for contract award. In this step, proposals forwarded were evaluated by technical advisors and cost analysts at the workstations. They recorded their assessment on a proposal summary screen. This screen was then used to present their findings and recommendations to the voting members. The voting members then met, held discussions supported by the proposal summary screen, and voted on the proposals to be recommended to the SSA for award. The same proposal summary screens were used to brief the SSA on the evaluation results and obtain his award decisions.

The most frequently asked question, and the most difficult to answer relative to this process, is: How much money did you save? A quantifiable response to this question is probably unattainable. There is no direct comparison between what was accomplished in execution of this procurement and any other known procurement. However, metrics exist which illustrate the savings. The cost of the computer hardware and software used to accomplish the evaluation is not considered an evaluation cost. The hardware and software will be used to support a variety of program activities, including future procurements.

Routhly estimated, the paperless process saved about 132,000 pieces of paper. Use of electronic vs. paper proposals saved about 75,000 pages. Electronic vs. paper worksheets saved another 2,000 pages. The Short Form Research Contracts saved about 5,000 pages, and the electronic deliverables from the contracts will save another 50,000 pages.

Conclusion

This article has stated throughout that the process used was thorough and exceptionally efficient in the use of resources. The following items illustrate the efficiencies achieved.

Using the three-step paperless process, 10 evaluators read all 154 proposals and identified those which were of interest to the JAST program. In Step Two the remaining proposals were each reread by three evaluators, who briefed the other evaluators, all of whom had already read the proposals.

In Step Three, proposals brought forward were reviewed thoroughly by technical advisors and cost analysts, and briefed to the voting members — the third review for each of these proposals. This was accomplished in nine working days without the need for extended hours. On the morning of the 10th day, the SSA was briefed and award decisions made.

Assessment of all ten highly experienced evaluators was that this process was the most thorough and efficient proposal evaluation in which they had ever participated. Thus, even if there were no fiscal savings, the efficiency and thoroughness of the process is adequate justification for using paperless evaluation processes.

The subjective assessment of the evaluators, and other close observers, was that a "paper evaluation"

FEDERAL ACQUISITION STREAMLINING ACT OF 1994 (S. 1587) PASSED PRESIDENT SIGNS INTO LAW

On 20 September, the House of Representatives, by a vote of 425 to 0, agreed to the conference report to accompany S.1587: To revise and streamline the acquisition laws of the federal government, and for other purposes. The Senate had adopted the conference report by voice vote on 23 August. The President signed the bill into law on 13 October.

The November/December 1994 issue of *Program Manager* will include an article by Mr. Joseph Drelicharz, Professor of Systems Acquisition Management, DSMC, outlining the provisions of the Act and its implications throughout the acquisition community.

equally thorough and of the same magnitude, would have required two months time. Using this metric, the savings amount to six-weeks time for 10 evaluators and four support personnel. The technical and cost advisors, 20 individuals, completed their work in two days. In a traditional evaluation, they probably would have required three weeks for the same effort.

Data management and documentation is another area where this process provided significant savings. Execution of a source selection is always a major exercise in data management. Data management is directly proportional to the number of proposals, evaluators and steps in the evaluation process. In this case, the data management task was monumental: 154 proposals, 10 voting evaluators, three steps and 20 technical and cost advisors. More than 2,000 worksheets were generated.

The database system used made this task incredibly efficient. One person administrated the entire evaluation and no additional personnel resources were required to perform the data management task. A paper evaluation of equal magnitude would have required about four full-time individuals, and would have had a high potential for errors. Using this system, all data was automatically and accurately compiled and available instantly.

Using the vast quantity of information available in the database, reports in any format desired and containing any of the information recorded could be produced easily and quickly. Further, the entire evaluation process was fully documented the moment the SSA made his award decisions. In a typical, nonelectronic evaluation, documentation of the source-selection process takes about two months to accomplish after the source selection is completed.

Time to accomplish the solicitation is another important consideration. This solicitation required less than four months from idea to contract award. A comparable procurement for tactical aircraft concept exploration and definition studies which was considered a model effort, took almost 11 months. Another comparison drawn from the NAVAIR Procurement Planning Guide shows a typical procurement execution timeline of 63 weeks to complete a similar procurement process.

This initial acquisition activity was a small first step, but it demonstrated clearly the benefits of electronic commerce to both government and industry.

The space available in this article is insufficient to fully describe the processes we used and to present the lessons learned. If you would like to learn more, the JAST Program has three products available free to U.S. Government organizations: (1) a video describing the streamlined and paperless processes used; (2) a paper containing lessons learned and which describes more fully the approach used to streamline the procurement and execute the paperless evaluation; and (3) a manual providing documentation of the database software developed for this paperless evaluation.

To request any of this information, call Dave Hersh in the JAST Program Office at (703) 602-7390, Ext. 6642, via Internet at hershds@ntrprs.jast.mil, or Fax (703) 416-8440.

RISK IN THE ACQUISITION PROCESS

A Better Concept

Lt Col Norman E. Johnson, USAF

Acquisition management is risk management. It consists of identifying risks associated with cost, schedule and performance, and then managing those risks to minimize overall program risk. In their guidebook, *Risk Management Concepts and Guidance*, the Defense Systems Management College (DSMC) develops a framework for risk management for acquisition. This excellent model defines risk as "the probability of an undesirable event occurring and the significance of the consequence of the occurrence." In practical application, this means the acquisition manager must use a certain amount of subjective judgment to assign probabilities and consequences. Additionally, he or she must use judgment to determine the risk resulting from the relationship between those probabilities and consequences. Several models exist to help with the latter, but they are not consistent and tend to be somewhat imprecise.

In this article, I examine the relationship between probabilities and consequences and propose a more precise model that will reduce the reliance on subjective managerial judgment when assessing risk.

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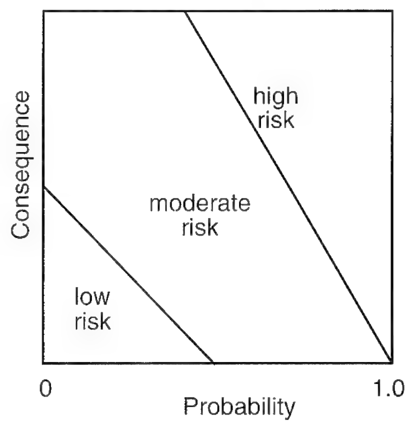
Figure 1. Flying Safety Concept of Risk



Source: AFFTCR 127-3

Background

In my experience as an Air Force flyer, I became familiar with the flying safety community's concept of risk as shown in Figure 1. This concept shows that an event with a low probability of occurrence and a low consequence if it does occur would present a low risk. On the other hand, an event with a high probability of occurrence and a catastrophic consequence would present a high risk. The area in between represents a transition from low to high risk, and we label it moderate risk.

The DSMC presents two slightly different concepts of risk, as shown in Figures 2 and 3. Note in these concepts the axes are the reverse of the flying safety concept.

All the concepts agree that a risk-rating system should be kept simple with low, moderate and high designations. They also agree that the lower left quadrant generally represents low risk and the upper right quadrant generally represents high risk. They differ in how the other two quadrants are interpreted:

— High probability, low consequence. In Figure 2, the first DSMC concept, the upper left quadrant represents low risk. In Figure 3, the second concept, the upper left quadrant generally represents moderate risk. This corresponds to the lower right quadrant of the flying safety concept in Figure 1, which also generally represents moderate risk.

Figure 2. DSMC Concept of Risk

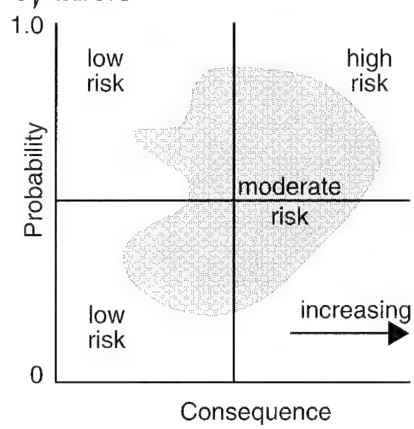
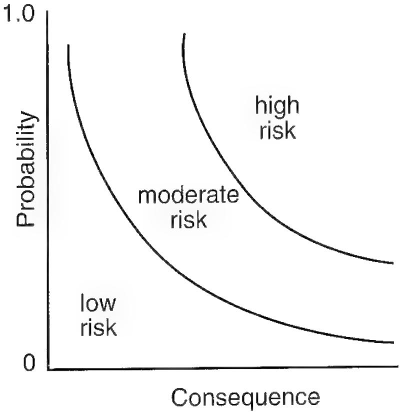


Figure 3. DSMC Risk Rating



— Low probability, high consequence. Interestingly, DSMC illustrates this quadrant with an example based on flying safety: flying in a commercial airliner is low risk because, although the consequences of a crash are severe, the probability is low. However, in Figure 1, the flying safety concept would classify this condition as moderate risk. The second DSMC concept, Figure 3, represents this quadrant as generally representing moderate risk, but it also reflects the low risk nature of this example. The first DSMC concept, Figure 2, represents this quadrant as "increasing risk" and describes it as "more subject to individual interpretation and requires strict program guidelines for rating the risk."

The DSMC hones the concept of risk by differentiating it from uncertainty. Risk stems from an event associated with a known probability distribution. Uncertainty stems from an event associated with an unknown probability distribution. In actual practice, especially in the acquisition world, probability distributions are never very well known. Normally, we apply judgement to make various assumptions to achieve acceptable approximations. Finally, in their discussion of rating schemes and definitions, DSMC concludes, "The definition issue becomes one of identifying impacts and deciding on a scale(s) and then shaping the boundaries between the three regimes." They recognize that judgment is required for each of these endeavors. I propose that shaping the boundaries can be more objective and less reliant on judgment.

Shaping the Boundaries

The foregoing discussion showed an obvious lack of agreement on the shape of the boundaries between risk levels. In this section, I offer some assertions to add more precision to the shape of the boundary curves.

• Assertion 1. Probability is the independent variable and should be on the x axis. Although the axis selection is somewhat arbitrary and the same results will be achieved either way, it is important to establish a convention so everyone has the same point of reference. I contend that an event must occur before a consequence results. In other words, the consequence is dependent on the event occurring which is represented by probability. Figure 1 reflects this assertion.

• Assertion 2. Probability is bounded at both ends, consequence is only bounded at the lower end. By definition, probability can only assume values between 0 and 1 inclusively. Some events can have a 0 consequence, but other events can have unmeasurably high consequences. Furthermore, consequences cannot be negative. From the DSMC definition of risk, we are dealing only with undesirable events. A negative consequence would, therefore, represent a desirable event and is incompatible with the concept of risk. In fact, the favorable results of a particular event become the subject of another decision after the risk is determined — the acquisition manager must weigh the risks of a particular action against the benefits.

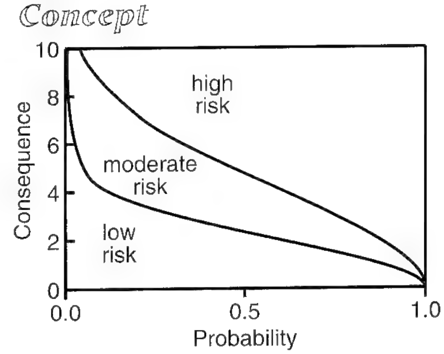
• Assertion 3. As probability approaches 1.0, risk becomes undefined. Whether the consequences are grave or negligible, the event is imminent. The problem becomes one of damage control, not risk management. None of the risk concepts presented earlier reflect this assertion adequately.

• Assertion 4. At probability 0, risk is in the low regime. Whether the consequences are grave or negligible, the event is not possible. No risk is associated with a nonevent. Figures 2 and 3 reflect this assertion.

• Assertion 5. The nature of the risk is different on each side of the point where probability is 0.5. This assertion reflects an intuitive sense about risk. You tend to manage things differently if the odds are against rather than if the odds are with you. Figure 2 reflects this assertion by separating quadrants at the point where x = .5.

What sort of graphical concept reflects all of these assertions? I offer the concept shown in Figure 4. Assertion 1 obviously is incorporated. Assertion 2 is satisfied by the asymptotic nature of the curves as x approaches 0. A finite difference exists between risk levels at any conceivable consequence level. Assertion 3 is satisfied by the curves converging at the point where probability is 1. At that point, risk is neither low, moderate nor high; it is undefined. The curves converge rather steeply to that point to reflect the fact that, even though imminent, an event with very little consequence is certainly not a high risk and hardly a moderate risk. Assertion 4 is satisfied by the asymptotic nature of the

Figure 4. A Better Risk Concept



curves as they approach x = 0. A highly unlikely event is low risk even if the consequences are catastrophic. Recall the example of flying on a commercial airliner. Assertion 5 is satisfied by the inflection point at x = .5. When x < .5 the slopes of the curves are increasing, similar to the curves in Figure 3. When x > .5, however, the slopes are decreasing. Although the change is very gradual, the nature of risk is different on either side of the break-even odds.

If you are familiar with statistics, you may recognize these curves as Gaussian, or bell-shaped, curves that have been rotated sideways. The Gaussian function occurs throughout nature from nuclear physics to biology to cosmology. I cannot rigorously prove that it also applies to boundaries between risk levels, but it is certainly intuitively appealing to use it. The appendix contains more detail on the actual mathematical expressions. Selecting coefficients to vertically position the curves belongs in the same decision arena as determining the scale for the y axis and no doubt requires judgment. For this presentation, I selected coefficient values so the tangents to the points where x = .5 have slopes of -3.33/1 and -6.67/1 for the lower and upper curves, respectively. Other than making this decision about scale, no other judgment is required to determine the actual shape of the risk boundary curves.

Conclusion

The concept of risk is fundamental to the acquisition system. A concrete risk concept would minimize error propagation throughout the entire risk management process. Unfortunately, the process of assessing risk is nonrigorous, subjective and relies heavily on judgment. The concept I presented in this article adds some measure of objectivity to the risk assessment process by defining the shape of the curves separating the risk regimes. The risk assessment process is still very imprecise and a great deal of judgment is required to assign probability and consequence values to a range of possible events. With this concept of risk, however, less judgment is required when examining the combination of the two.

References

Risk Management Concepts and Guidance. Defense Systems Management College. Washington: U.S. Government Printing Office, 1990.

"Safety Planning for AFFTC Projects." AFFTCR 127-3. Edwards AFB, Ca, 11 January 1990.

THE GAUSSIAN FUNCTION

The familiar bell-shaped curve is expressed by the Gaussian function:

$$Y = ae^{-bX^2}$$

To represent the curves shown in Figure 4, we need to rotate the curves 90 degrees clockwise. To do so, we make the following substitutions:

$$X = y \quad Y = -x$$

So, the equation becomes:

$$-x = ae^{-by^2}$$

algebraically rearranging produces:

$$y = \sqrt{-{}^1/_b \ln(-{}^1/_a x)}$$

The constant, $-{}^1/_a$, determines the x-intercept of the curve. To comply with assertions 2 and 3, we want the curves to intercept the x axis at x = 1. Furthermore, the argument of the natural log must be greater than 0. Therefore, we choose a = -1. Let us also define another constant:

$$k = \sqrt{{}^1/_b}$$

This constant determines the slope of the curve at any given value of x which also determines the vertical spread of the curve.

So, the final expression for our curves is:

$$Y = k\sqrt{-\ln x}$$

As mentioned in this article, we also are interested in the slopes of the curves, specifically at x = .5. We know that the slope, m, is equal to the first derivative of the equation for y:

$$m = dy/dx$$
$$= 1/2\ k\ (-\ln x)^{-1/2}(-1/x)$$

Setting x = .5 and solving for k in terms of m, we arrive at:

$$k = -.833\ m$$

In this model, I arbitrarily selected slopes for the upper and lower curves to be -6.67 and -3.33, respectively. This results in values for k being 5.55 and 2.77, respectively.

PHYSICS OF FAILURE

A Science-Based Approach to Ultra-High Reliability

Michael W. Deckert

In this time of decreasing budgets, great emphasis is placed on doing more for less. System reliability is an area where great savings can be accomplished by utilizing design and assessment methodologies which address the root causes of failure (i.e., a physics-of-failure (POF) approach). Using such science-based reliability techniques early in the design process can yield great cost savings in manufacturing, testing, fielding and sustainment of a new system. Additionally, a POF approach is needed to assess the reliability cost impacts of utilizing commercial and new technologies in system design.

Modern military systems rely heavily on large quantities of electronics. System readiness depends to a great extent upon the reliability of the electronics. Each electronic subsystem with its associated circuit card assemblies (CCAs) and individual components must be reliable, without unexpected failure during the service life of the system. Selection of a reliability assessment approach is a fundamental choice made by those concerned with the cost-effective design of reliable electronic hardware.

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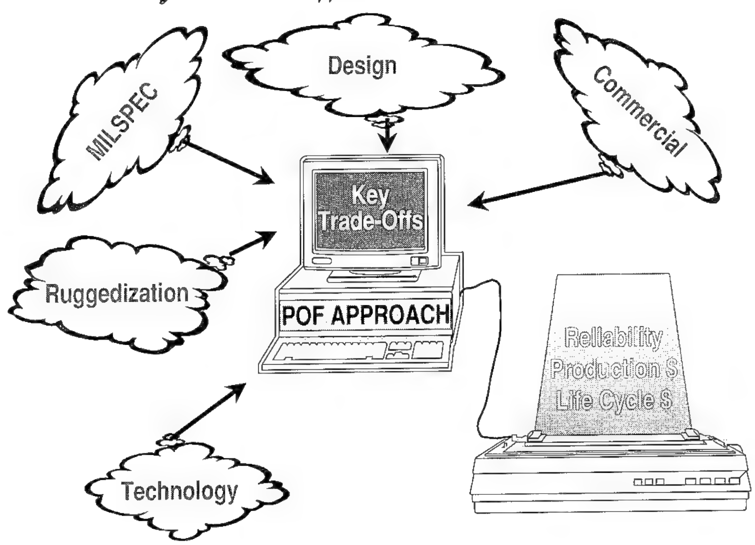
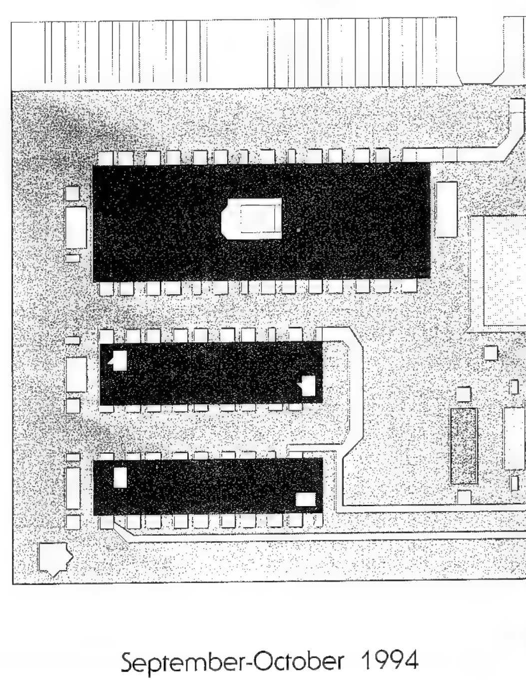
FIGURE 1. Key Trade-offs



Key trade-offs between commercial vs. military specification components, ruggedized vs. nonruggedized boards, emerging vs. traditional technology, and design layout (Figure 1) occur early in a program and can significantly impact the reliability and life-cycle costs of a system. The POF modeling and simulation tools provide program managers (PMs) and system designers with a science and engineering based approach for evaluating these types of trade-offs that can profoundly impact a program.

Concept

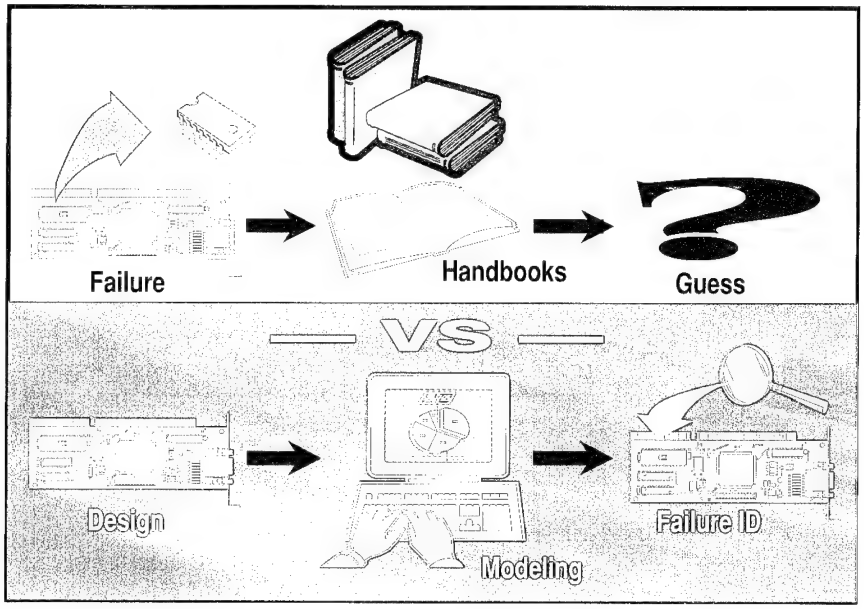
Traditional reliability assessment techniques for microelectronics are based on empirical models fitted to field data and are available in several handbooks. These techniques have long been criticized for their shortcomings. This concept of reliability, normally quantified by assessing the mean time between failures, implies that field failure is inevitable. The



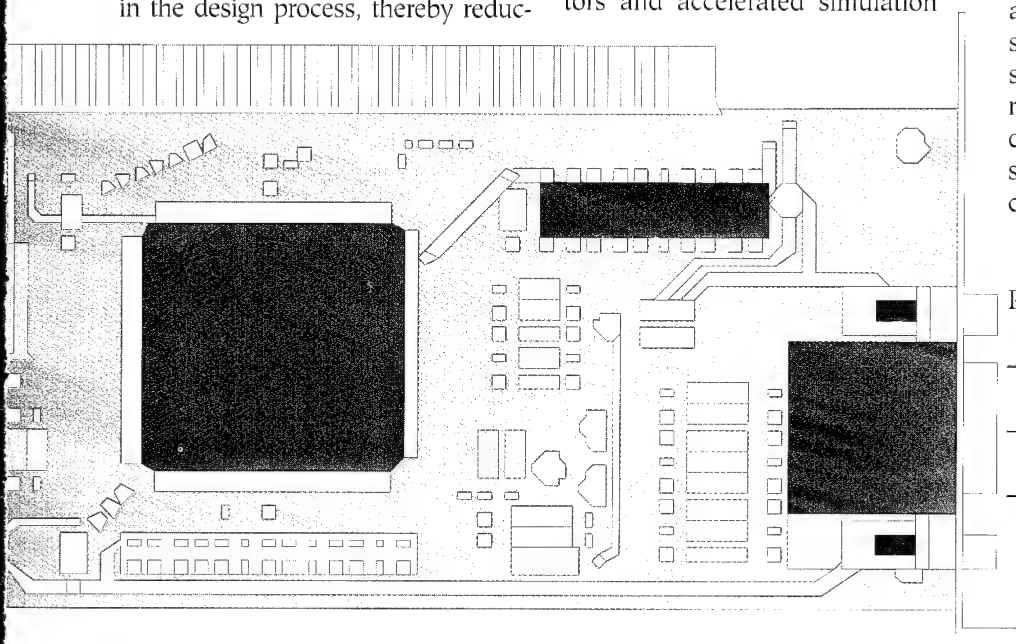
empirical failure models used by these handbooks are typically not derived from, or based on, any physics or mechanics of failure, and as such, they do not give the designer insight into, or control over, the actual failure mechanisms. Thus when designing, screening and testing a new product or a product with new technologies, these models may be inappropriate and misleading.

Until recently, these techniques have continued to survive since there has been no viable alternative. Now the POF approach exists — a practical, science-based alternative. In contrast to the "traditional" approach, the POF approach uses modeling and simulation techniques to identify first-order failure mechanisms prior to physical testing (Figure 2). The POF technology and computer tools have been developed by the Computer-Aided Life-Cycle Engineering (CALCE) Electronic Packaging Research Center (EPRC) at the University of Maryland with the support of industry, government and other universities. The U.S. Army Materiel Command (AMC), with the U.S Army Materiel Systems Analysis Activity (AMSAA) as the Army lead activity, has supported the POF technology development efforts which have produced microelectronic device design tools that eliminate sources of failure early in the design process, thereby reducing required testing, shortening the development cycle, and increasing weapon system reliability.

FIGURE 2. Traditional vs. POF Techniques



The POF is an up-front approach to reliability that focuses on preventing failures through robust design and manufacturing practices based on: life-cycle loads and stresses, product architecture, and potential defects and failure mechanisms. The approach incorporates reliability in the design process by establishing a scientific basis for the evaluation of new materials, structures and technologies, and by designing tests, screens, safety factors and accelerated simulation methods. The approach incorporates reliability in the manufacturing process through understanding how to best utilize and enhance manufacturing capabilities to promote high quality. The traditional reliability assessment techniques heavily penalize new materials, structures and technologies because of the lack of sufficient failure data. This approach, based on the "fear of the unknown" rather than any science-based analysis, discourages change, hindering the process of reliability enhancement. The POF approach, on the other hand, is based on physical failure models which are as effective for new materials and structures as they are for existing designs. The new approach is a dual-use method which encourages innovative designs by a realistic reliability assessment whether the application is commercial or military.



The basic steps to implement the POF approach are the following:

— Define realistic product requirements.
— Define the design usage environment.
— This usage profile defines the mechanical, thermal, electrical and chemical loads that are experienced over time. These loads may

be associated with manufacturing, testing, storage, repair, handling and operating conditions.

— Identify potential failure sites and failure mechanisms. Critical parts and their interconnections, and potential failure mechanisms and modes must be identified early in the design. Potential architectural and stress interactions also must be defined.

— Characterize the materials and the manufacturing and assembly processes. To assume structures are free of defects is unrealistic and potentially dangerous. Materials often have naturally occurring defects, and manufacturing processes can induce additional defects.

— Design to the usage and process capability. The design stress spectra, the part test spectra, and the full-scale test spectra must be based on the anticipated life-cycle usage conditions. These steps become an iterative process of system design, design analysis and system redesign (Figure 3) to develop a reliable cost-effective product that meets some set of realistic requirements.

Tools

The POF modeling and simulation tools (Figure 4) are key elements in the overall POF approach of determining the robustness of the system design and manufacturing practices with respect to reliability. Two such computer-based modeling and simulation tools are called Computer-Aided Design of Microelectronic Packages (CADMP-2) and Computer-Aided Life-Cycle Engineering (CALCE). The CADMP-2 assesses the reliability of electronics at the package level while CALCE assesses the reliability of electronics at the printed wiring board level. Together, these two models provide a framework to support a POF approach to reliability in electronic systems design.

FIGURE 3. POF Design Process

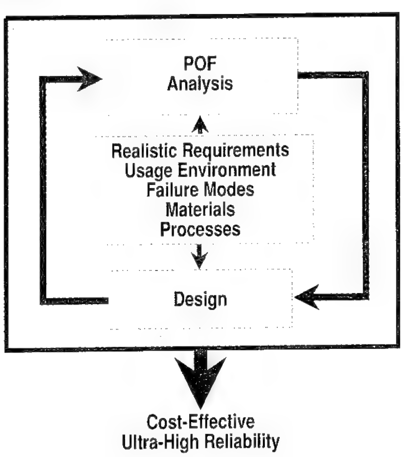
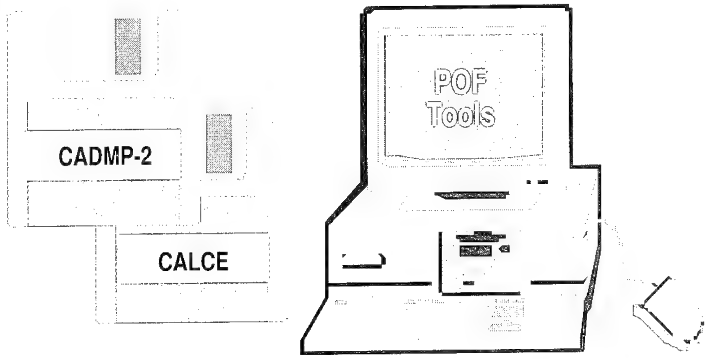


FIGURE 4. Tools to Support an Overall POF Approach



CADMP-2

The CADMP-2 is a set of integrated software programs that can be used to design and assess the reliability of integrated circuit, hybrid and multichip module packages. The CADMP-2 was developed by the CALCE EPRC of the University of Maryland, and is based on the POF approach to electronic package design. The CADMP-2 aids in assessing component reliability during the design phase; evaluating new materials, structures and technologies; assessing packages designed by other software programs or manufacturers; and developing cost-effective products.

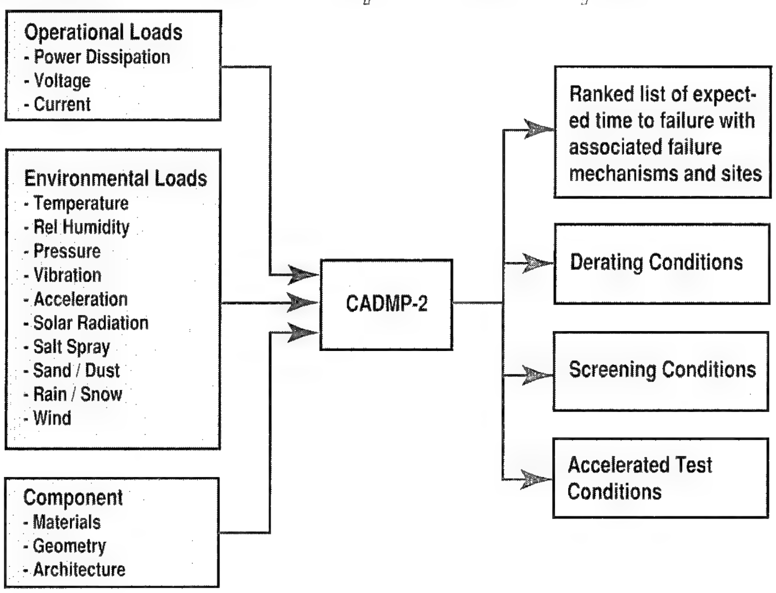
The CADMP-2 software tools are used to assess the reliability of packages subjected to different environments and design constraints. An overview of the CADMP-2 inputs and outputs is shown in Figure 5. The CADMP-2 also aids in the selection of package type, package-to-board mounting technology, interconnections and substrates. During the CADMP-2 assessment process, an average time to failure is determined for each potential failure mechanism using models based on package geometric and material parameters, as well as the environment in which the package will function. Potential failure mechanisms at the potential failure sites can be ranked to identify weak links in the package. The CADMP-2 performs thermal stress analysis including conductive and convective analysis. Calculations are based on data stored in material, environment, failure mechanism and parts libraries.

CALCE

The CALCE software provides an integrated design environment used to incorporate various tools associated with reliability, supportability, producibility and costing tasks into the design of electronic systems in the earliest stages of the design process. The CALCE software was developed by the University of Maryland CALCE center and is based on a POF approach to printed wiring board design.

The CALCE software is a set of integrated tools for the design and analysis of electronic assemblies. Figure 6 provides an overview of the CALCE input and outputs. The software can be used for the design of complex multilayer printed wiring boards, including the selection and placement of components. The CALCE software can determine the component junction, case and sub-

FIGURE 5. CADMP-2 Inputs and Outputs



strate temperatures. The software calculates component and system failure rates, vibrational effects on component leads, and thermal and mechanical solder joint fatigue for surface mount devices.

Applications

Generally, the work performed early in the development of a new or modified system focuses on performance, and does not take into account adequately the impact of other areas such as reliability. During this early period, pre-Milestone 0 to Milestone II, Integrated Product and Process Development can have its greatest impact. Traditionally, reliability has been sought through a Reliability Growth Test (RGT) program, which can be very expensive.

The POF methodology and computer tools can reduce the number of time-consuming and expensive hardware test iterations. In fact, it is becoming feasible to improve reliability in the conceptual design stage by connecting the contractor and the military reliability team members before expensive manufacturing commitments are made. Physics-of-failure methodology and design tools allow reliability engineering to become "proactive" rather than "reactive," and has numerous applications throughout the materiel acquisition cycle (Figure 7).

Accelerated Testing

Test time and money can be reduced significantly by using accelerated testing. However, a way must exist to evaluate equipment reliability based on accelerated test results. Since different failure mechanisms follow different life distributions, they also may have different acceleration models. To properly develop an accelerated test methodology to reduce testing, a POF approach is required. The POF methodology can be used to design specific accelerated tests as well as general testing guidelines to ensure the testing can be correlated correctly with equipment reliability. An accelerated life test on the main processor CCA for the U.S. Army Joint STARS program will be conducted using the CALCE and CADMP-2 POF tools to determine failure mechanisms and assist in the accelerated test design. The accelerated test will be used to determine if a commercial CCA is as reliable as a ruggedized CCA to be used in the light ground station module. Cost savings for the commercial ($6,000) vs. the ruggedized ($19,000) CCA is substantial.

Logistics

The POF concepts can improve depot maintenance of electronic equipment in three areas: failure verification and isolation, improved reliability after repair, and improved repair verification. When an electronic item comes into the depot for corrective maintenance, depot maintainers frequently are unable to detect failure resulting in no evidence of failure (NEOF). Many of these NEOFs are due to failure modes which are intermittent or marginal, and multiple field failures can result from one intermittent or marginal failure. For example, a solder connection on a CCA is expected to fail due to fatigue resulting in an intermittent electrical connection that is only detectable at a particular vibration profile. At present, depot maintainers run diagnostics at

FIGURE 6. CALCE Inputs and Outputs

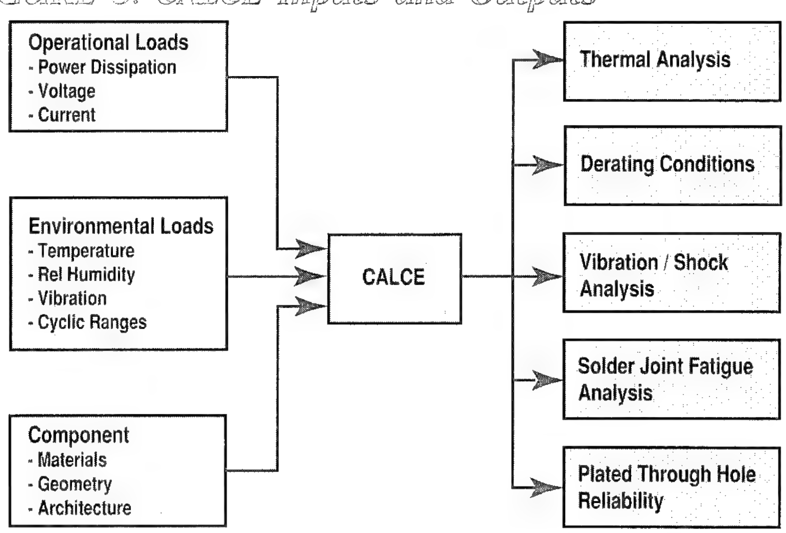
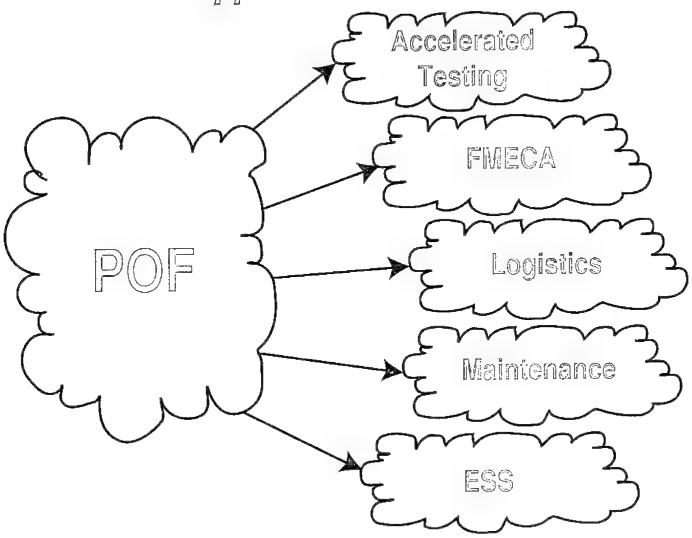


FIGURE 7. POF Applications



benchtop conditions and would categorize the CCA as NEOF. With the POF approach, operational and environmental loading profiles for failures most likely to occur would be used for failure verification.

Maintenance

Currently, unfailed electronic items are erroneously assumed to be as "good-as-new" items. However, many failures in electronics are due to wearout. With the POF approach, the good-as-new assumption would not be used during development of repair procedures. For example, if a CCA has wearout failures of two integrated circuits which are expected to occur at similar amounts of usage, the current approach is to replace only the first integrated circuit that failed. The CCA is then assumed, incorrectly, to be as good as a new CCA. Utilizing the POF approach, both integrated circuits would be replaced when one failed.

Environmental Stress Screening

Repair of an item can introduce defects just as much or more than original manufacturing. Currently, the depots are instituting environmental stress screening (ESS), usually relying on temperature cycling and vibration, to precipitate defects introduced during repair. A POF approach can help eliminate much of the guesswork required for the development of ESS procedures. The ESS procedures are supposed to be designed to use up, at most, 10 percent of the useful life of the item. This is especially important for the used items that depots repair. A POF analysis is the only way to determine how much useful life remains.

FMECA

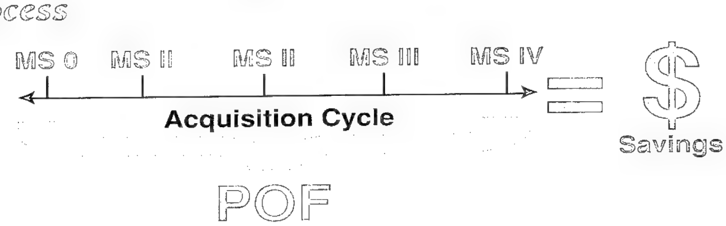
Currently, the failure modes and effects criticality analysis (FMECA) on electronics components are based on a functional approach that does not account for many of the actual failures in the field. The potential of hardware approach FMECA has not been able to be exploited since the reliability technology required to accurately determine the key hardware failure modes, the stress conditions required for their detection, and their likely order of occurrence has not been available for modern electronic CCAs and for the microelectronic devices that populate these assemblies. For example, the FMECA assumes the integrated circuits either failed open or failed short. This is not necessarily representative of how cards and devices will actually fail, and does not account for the subtle intermittent or marginal failure modes. Using POF automated reliability assessment tools can provide expected failure times, sites and stress drivers for the key failure mechanisms associated with an electronic CCA.

Summary

The implementation of the POF methodology into the materiel acquisition process can yield significant cost savings (Figure 8). The earlier POF methodology is applied to the process, the greater the potential cost savings. Physics-of-failure modeling and simulation tools provide PMs and system designers with the only science and engineering based approach for evaluating key design specification and technology trade-offs that can have a profound impact on a program. The advantages of applying the POF reliability assessment techniques to the materiel acquisition process surpasses those afforded by traditional reliability assessment techniques.

The Army has started POF research in the areas of mechanical systems, electro-optics, and box level electronics. Automated modeling and simulation tools that assist in the application of an overall POF approach will be developed for each of these research areas. The electronic component and circuit card level tools (CADMP-2, CALCE) have been completed, and are available for designers to use as tools to support an overall POF approach, prior to the completion of a comprehensive electronic tool set.

FIGURE 8. POF Applied to Material Acquisition Process



DO WE NEED THE STATEMENT OF WORK?

A Radical Argument for Elimination

Dr. Jerome G. Lake

For years I taught about statements of work (SOWs) — what they are, how they are prepared by the tasking activity, and how they are utilized to cost, plan and control contractual work by a performing activity. My teaching was based on the premise that the SOW is one of four essential technical documents provided by the tasking activity in a request for proposal (RFP) and the basis for work to be accomplished under contract. The other three complementary technical documents included in my instruction are specifications, contract data requirements lists (CDRLs) and a work breakdown structure (WBS).

I assumed the SOW is essential to the work effort and that without it the performing activity couldn't do the contractual effort, or the tasking activity couldn't know and monitor what the performing activity was doing. I long recognized that SOWs are poorly prepared and that, in spite of this, contractual efforts are generally accomplished to tasking-activity satisfaction, albeit with cost overruns and schedule delays.

Recently my paradigm on the SOW was challenged. During a class I taught on systems engineering trends in a Defense Systems Management College Executive Management Course, a senior executive asked, "Why can't we do away with the statement of work?" He went on to assert, "It isn't needed!" This came at me from left field. It was outside the box! I therefore easily dismissed it with standard rhetoric. After all, isn't the SOW to the acquisition world what the Bible is to the Christian world?

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The question of need and value, however, became ubiquitous. With each successive class on systems engineering, the question pursued me as I taught the essentials and merits of the SOW according to the book (MIL-HDBK-245C). This led me to play devil's advocate and challenge students to think about the need for a SOW. Like I did, each class defended the existence and value of the SOW. Performing activity contractors have been particularly outspoken in support of the need for a SOW.

Reflection on the challenging statement from the senior executive has led me to a different conclusion, however. The purpose of this exposition is to explain why I now teach that the SOW is a redundant document and not needed, in its present form, by the tasking activity or the performing activity to accomplish the work associated with a contract.

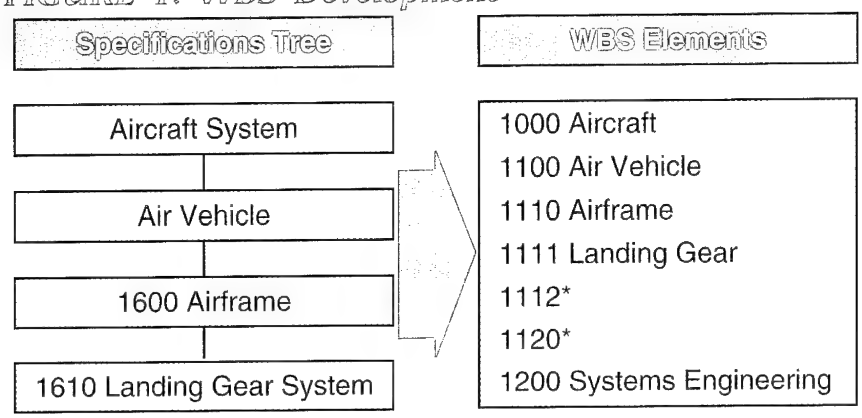
I realize that such a position is against conventional wisdom. But, in this era of acquisition reform, a fertile ground exists for such a contrary seed to grow and bear fruit. Therefore, with vigor I attack the windmill. I challenge you to reflect on the arguments made in this paper. Look into the deep of each provoking rationale provided. Don't dismiss the challenge early. An opportunity may be missed to reform acquisition and cut out time delays, confusion and unneeded costs. Adopting the radical thoughts offered herein may actually lead to quality systems being realized within cost and schedule goals and without the excessive change costs associated with today's acquisitions.

Identify the Expert

Who is the expert in doing the contractual work? Is it the tasking activity or the performing activity? Your answer ought to be the performing activity. They get the contract because the expectations of the tasking activity include the fact that the performing activity provides the experts to not only do contractual tasks but also to define what those tasks are and how they will accomplish them.

The main function of the SOW boils down to telling the performing activity what to do. A fair question is "To do what?" Usually this is provided to the performing activity in Section I of the SOW — Scope. This section is nonbinding. It is intended to provide to the performing activity a word picture of the purpose of the contractual endeavor. It may be as simple as to develop, fabricate, assemble, integrate and test a "Fuzzy Whopper," or some similar product. Then, in Section II of the SOW, the tasking activity provides the list of reference documents for guiding the performing activity in accomplishing

FIGURE 1. WBS Development



the work related to the contract. In this controversial and misunderstood section, work is constrained, further defined, and often tiered through a maze of multiple documents referenced by those listed. Usually, the work directed through these documents is not intended by the tasking activity, but is included as a result of the unfamiliarity by SOW preparers.

The tasking activity is generally unfamiliar with how or what to tailor out and how to prevent tiering. A misunderstanding exists about where the tailoring is accomplished. Many practitioners, who have not read MIL-HDBK-245C, tailor the documents, if tailored at all, in Section II. The handbook calls for tailoring to be done in Section III. [Authors note: Since writing this article, Dr. Perry's announcement in June 1994 restricts the use of most, if not all, specifications and standards in an RFP. This will mitigate, to some extent, the tiering problem. It will also cause the tasking activity to rely on the experts — the contractors — to determine which specifications and standards to apply to the contractual effort.]

The third section of the SOW is the most important. It details the nonspecification work the performing activity is required to accomplish. This is the section most often poorly prepared by the tasking activity. I have seen several Sections III obviously copied from other program SOWs. Evidence at the trivial end includes the name of other programs. Evidence at the nontrivial end includes work intended for an entirely different acquisition phase or level of development. This later occurrence leads to interesting and creative responses in performing activity proposals.

The MIL-HDBK-245C acknowledges the problems found in Sections II and III of the SOW by including numerous cautions to which tasking activity preparers should pay heed. Unfortunately, surveys taken in numerous systems engineering classes find that few government taskers used MIL-HDBK-245C in preparing past SOWs. In fact, few knew of the existence of a handbook that would aid in SOW preparation.

In 1990, Adler and Andrews waxed eloquently on the problems associated with SOW development. They presented survey results that highlighted the poor quality of SOWs and the lack of awareness of MIL-HDBK-245 and its requirements.

Of course, the fact that SOWs are not well-prepared, or that the experts are not the preparers, is not sufficient rationale for doing away with the SOW. For these reasons, SOW classes are held for acquisition personnel. For example, in a follow-up article to their provocative 1990 writing, Andrews and Adler, in 1991, posed the question, "Is the SOW as important as it has been made out to be?" Their conclusion was "they think so." They stressed that education is the key to fixing SOW efficiencies. (Unfortunately, they never did an analysis of the need for a SOW.)

Although not sufficient for doing away with the SOW, such observations point out the reality that SOWs have not played a major role in leading to quality system developments. Performing activities seem to do the right things in spite of poor SOWs.

Some students have contended that they realize the performing activities are the experts, so they have that activity prepare the SOW during an earlier contractual effort for a future, follow-on contractual effort. Such an argument creates another question. "If the performing activity is going to tell the tasking activity what work that they must do to accomplish a development effort, why bother with a SOW at all?"

Why a SOW Is Not Needed

Arguments on why a SOW cannot be eliminated usually rest on the need to cost the work and to track the performance progress of the work. At first this seems valid, until one appreciates and understands what is included in, and directed by, the other three technical documents included in a contract and/or an RFP, and what future standards on systems engineering impose to ensure that lengthy SOWs will not be missed. Each document will be explained separately. However, one must appreciate that without the synergism of all these documents, the work usually included in a SOW will not be accomplished, let alone be satisfactory. The documents of the RFP/contract must be prepared so all directions work together toward the desired contractual objectives.

Specifications

The main purpose of a development is to create products and their associated processes that meet or exceed customer and public expectations. The primary purpose of a speci-

fication is to relate to the performing activity exactly what the system (product) must do and its characteristic attributes; included is how each requirement will be qualified.

When functional and physical requirements are allocated to specific elements of the physical architecture, a specification tree is generated. This specification tree reflects the interrelationship of performance and physical requirements, and provides a construct for the development of the product part of a WBS. Figure 1 illustrates the relationship between specifications and the WBS.

Specifications have been specifically excluded from SOWs (except for Type 0 and Type IV SOWs when needed to guide concept development or specific services, respectively). Therefore, a SOW is not needed to provide performing activities work requirements related to product performance and characteristic attributes.

Work Breakdown Structure

The products identified in the product part of the WBS must be developed to satisfy the operations function of the system. Associated processes — systems engineering and integration (development), manufacturing, support (to include distribution/deployment, disposal and support equipment), verification/test, and training — are added to the product structure to reflect the hierarchical family tree of products and process that make up the system.

Current SOWs are redundant, not well-prepared, and lead to confusion and inefficiencies in providing high-quality products and services with correct performance features at an affordable price and on time.

With the addition of program management concerns (program management, spares, data, etc.) of MIL-STD-881B, the resulting WBSs include all technical and management work, which the performing activity is required to complete. When generated for the appropriate level of development, program and contract WBSs reflect the products, processes and services that must be developed and provided by performing activities or supplied by the tasking activity.

The key element of the WBS which challenges the need for a SOW is the WBS dictionary. A typical WBS dictionary is provided in Figure 2. Generated during the prior level of system development and provided to the performing activity in the RFP, this dictionary provides the performing activity with the tasks needing completion with respect to a particular WBS element.

In my SOW instruction, I stress that the task of writing a SOW paragraph should not be difficult if the task description from the dictionary is included in the SOW. Thus, the SOW becomes a collection of WBS dictionary task statements. Looking back from my new vantage point, one of challenging the need for a SOW, I see the need to question why a SOW is necessary to repeat statements already available to the performing activity. Of course, this means a tasking activity needs to have a fully developed WBS for engineering the system and managing the system development, complete with the WBS dictionary, in the RFP.

Contract Data Requirements List (CDRL)

As work is performed to develop a product or process to meet specifications associated with a WBS element, data is generated. Decision

FIGURE 2. Example WBS Dictionary

Work Breakdown Dictionary

Index Item No. 2	WBS Level 2	CONTRACT NUMBER F33657-72-0923
WBS Element	WBS Title: AirVehicle	Contract Line Item: 0001, 0001AA, 0001AB, 0001Ac, 0001AD 0001AE, 0001AF, 0001AG, 0001AH
Date / Revision No.	Revision Auth / Approved Chg	
Specification No.: 689E078780028	Specification Title: Prime Item Development Specification for AGM 86A Air Vehicle/Airframe	

Element Task Description

Technical Content

The air vehicle element task description refers to the effort required to design, develop, fabricate and test the airframe segment, propulstion element, and fire control element, and to the integration assembly and check-out of these complete elements, to produce the complete Air Vehicle. The lower level elements included and summarized in the Air Vehicle element are:

Airframe Segment (A11100),
Propulsion Segment (A32100), and
Fire Control Segment (A61200).

Cost Description

MPC/PMC	Work Order/Work Auth
A10100	See lower level WBS Elements

Cost Content - System Contractor

The cost to be accumulated against this element include a summarization of all costs required to plan, design, develop, fabricate, assemble, integrate and perform development testing, analysis and reporting for the air vehicle. It also includes all costs associated with the required efforts in integrating, assembling and checking our GFP required to create this element.

Applicable SOW Paragraph: 3.6.2

makers require the information provided by this data to assess development progress and the quality of work performed. The CDRL tells the performing activity which data products are to be prepared and delivered to the tasking activity. Although MIL-HDBK-245C allows a CDRL, or the associated data item description (DID), to be referenced in a SOW paragraph (CDRL and/or DID number placed in parentheses at the end of a SOW paragraph), a request for, or discussion of, data is not allowed in a SOW paragraph. This is because (1) CDRLs are provided as a separate list in Attachment J of the Uniform Standard Contract format used for the RFP and contract, and (2) the labor and material costs associated with generating and delivering data should not be priced out twice — first as a CDRL item and again in a SOW paragraph.

Thus, since the CDRL directs delivery of needed data items, the SOW is not needed for data development. The performing activity knows that if it must be delivered, it must be prepared in accordance with the CDRL and appropriate DID.

If cross reference of data items is needed, this can be accomplished by adding referenced WBS element numbers to the CDRL or adding CDRL/DID references in the WBS element dictionary form.

The existence of specifications, CDRLs and WBS dictionary tasks in the RFP/contract are not sufficient to justify eliminating the SOW as structured today. Additional information is necessary. That information is found in the Systems Engineering Management Plan (SEMP) and the Systems Engineering Master Schedule (SEMS) requirements of two proposed industry standards on systems engineering, and currently used in most Air Force program developmental efforts. When prepared by the performing activity, these two planning documents are structured to facilitate their application contractually as an alternative to placing a standard on contract to execute systems engineering. These documents allow the performing activity (the real experts) to detail the work they will accomplish during the next contractual phase.

Systems Engineering Management Plan (SEMP)

The SEMP is intended to coordinate and integrate all technical plans and planning.

The forthcoming industry systems engineering standard, to be published by the Electronics Industry Association, recommends that a tasking activity prepare a SEMP to describe tasking activity systems engineering activities for the next contractual phase. The U.S. Air Force also requires it. Specifically, the tasking-activity SEMP provides responsibility for key systems engineering activities (by tasking activity or performing activity); plans and criteria for transitioning critical product and process technologies; identification of key trade studies and system effectiveness assessments; technical risk management plans; and tracking requirements for identified critical technical parameters. The tasking activity should provide this SEMP, in part or total, to the performing activity for use in proposal preparation.

The performing activity SEMP is to be prepared to respond to the tasking activity RFP. With the tasking activity SEMP as a guide, the performing activity SEMP describes the integrated set of WBS dictionary tasks. The SEMP prepared by the performing activity includes a summary, with reference to detailed plans, for all technical plans required by the CDRL of the RFP. The negotiated SEMP may then be placed on contract as the technical part of the SOW.

Systems Engineering Master Schedule (SEMS)

The SEMS is an event-based, not calendar-based, schedule/plan that includes a compilation of key accomplishments requiring successful completion to pass identified events. Events include technical reviews and audits, demonstration milestones, and decision points. The tasking of these events is normally included in a SOW.

Like the SEMP, a tasking-activity prepared SEMS is recommended in the forthcoming EIA Interim Standard 632 on systems engineering (a tasking-activity SEMS is required for Air Force programs). The tasking-activity SEMP should include top-level events throughout the entire program and detailed information for the next contractual phase.

Tasking-activity SEMS information should be provided to the performing activity in the RFP to establish major events and accomplishments which the providing activity would need to complete.

The providing-activity SEMS would be prepared as a response to the RFP, and submitted as part of the proposal. The performing activity's SEMP describes how the SEMS tasks are to be accomplished.

What Needs to Be Done

Obviously a Service program cannot eliminate the SOW unilaterally. Since it is part of the Uniformed Standard Contract Form (Section C), an RFP would not be released without a completed SOW. However, for commercial applications, the substitute documents outlined above can provide a basis for directing work without repeating WBS dictionary task statements in a separate SOW document.

For military procurements, contracting officials would most likely frown on the disappearance of the SOW. Being a realist, I do not recommend elimination of the SOWs. However, one can still take advantage of the documents described above.

The recommendation is that the SOW for system definition and sub-

system development be reduced. Sections I and II may continue to provide the scope of the effort and references applicable for the contractual effort. (References would need to be tailored in the WBS dictionary task statement.) Section III should be reduced to read as follows:

The contractor shall develop, conduct, provide and control the engineering and management effort in accordance with the provisions of the attached WBS dictionary tasks, CDRLs, and negotiated SEMP and SEMS.

For management tasks not included in the above documents, the recommendation is that the business plans included in management planning documents be used (e.g., the U.S. Army Program Management Plan or the Air Force Integrated Management Plan and Integrated Master Schedule).

Conclusions

Current SOWs are redundant, not well-prepared, and lead to confusion and inefficiencies in providing high-quality products and services with correct performance features at an affordable price and on time. The time for acquisition reform is now. One place to start is with the SOW.

This exposition challenges the conventional wisdom which dictates that a SOW be utilized to guide the performing activity in a contractual effort. Reform in acquisition requires a challenge to this thinking. I have asserted that a lengthy SOW is no longer needed. I have justified this assertion for acquisitions that have a specification, WBS, and CDRLs, and that require a SEMP, with an accompanying SEMS. The synergy of these documents, with other management documents and plans, provides necessary and sufficient information to guide performing activities in accomplishing a contractual effort, and to provide enough information to tasking activities to track and assess an effort.

The existence of specifications, CDRLs and WBS dictionary tasks in the RFP/contract are not sufficient to justify eliminating the SOW as structured today.

Radical ideas often create entrenchment by those who want to protect established and conventional methods. I challenge you to reflect on the arguments presented herein. I trust that such reflection will alter your mind-set on the need for a lengthy SOW associated with a contractual effort for development of a system, large or small, new or incremental. Where my logic has holes in it resulting from my lack of knowledge, don't prematurely throw away the ideas initiated herein. To my arguments, add your ideas and any needed documents available to the program office to help reduce the need of, and reliance on, lengthy SOWs.

Finally, until management directs the radical change encouraged herein, perhaps as you prepare your next SOW you will reflect on this article. Remember to flow the SOW from the WBS, use MIL-HDBK-245 as a guide, and tailor references in Section III. We just might get better SOWs.

(Previously published in the Proceedings of the 4th Annual International Symposium of the National Council on Systems Engineering, August 1994.)

References

Adler, T. R. and Andrews, R. A., "Is Your SOW a Statement of Work Or Source of Woe?" *Program Manager*, Vol XIX No. 3, Defense Systems Management College, Ft. Belvoir, Va.: May-June 1990.

Andrews, R. A. and Adler, T. R., "The 'Hither and Yawn (YON)' of Statement of Work Preparation." *Program Manager*, Vol XX No. 2, Defense Systems Management College, Ft. Belvoir, Va.: March-April 1991.

DoDI 5000.2, "Instruction for Defense Acquisition Management Policies and Procedures," Washington, D.C., 23 February 1991.

IEEE P1220 [For Balloting Draft], "Systems Engineering," December 1993.

Lake, J. G., "The Work Breakdown Structure: It's More Than a Cost Reporting Structure." *Program Manager*, Journal of the Defense Systems Management College, Ft. Belvoir, Va., July-August 1993.

Lake, J. G. "Implementation of Multidisciplinary Teaming." *Engineering Management Journal*, Vol. 4 No. 2 June 1992.

MIL-HDBK-245C, "Preparation of Statement of Work (SOW)," 10 September 1991.

MIL-STD-490B, Program Unique Specifications, Preparation of, Draft, Air Force Material Command, Wright-Patterson Air Force Base, Ohio, December 1992.

MIL-STD-499B (For Approval), "Systems Engineering," AFSC/ASD/EN, Wright-Patterson AFB, Ohio, 16 October 1993.

MIL-STD-881B, "Work Breakdown Structures for Defense Material Items," 25 March 1993.

MIL-STD-973, "Configuration Management." Joint Logistics Commanders, Manufacturing Modernization Directorate, Falls Church, Va., 17 April 1992.

COLOR OF MONEY

An Acquisition Manager's Guide

Lt Col David E. Price, USAF

Often, you may have heard the term "color of money" used to describe the differences between appropriated funds. This is an easy way to describe a complex set of financial laws and regulations. Most people in the Department of Defense (DoD) are familiar with the phrase; yet, few know the three basic elements that give appropriated funds their "color." Program managers (PMs) and others involved in the DoD acquisition process must understand basic funding rules. It would take volumes to address every "tint and shade" of money; however, the basic rules that color public money are not hard to understand. This article will provide an easy-to-read summary of the basic rules that govern the use of public funds.

Public Law

Is the color of money really important? Absolutely! To use more funds than Congress appropriated for a specific purpose and period, or to use funds for purposes other than those for which Congress intended those funds is a violation of the Anti-Deficiency Act. This Act is found in sections of Title 31 United States Code (U.S.C.) which limits the amount of public funds available for obligation and expenditure. To prevent Anti-Deficiency Act violations, the DoD is required to establish and operate a system of administrative control over appropriated and other funds which regulate and account for their use. Any violation of the legal restrictions imposed by the Anti-Deficiency Act must be reported under provisions of specific regulations promulgated by the individual military services (e.g., AFR 177-16, Administrative Control of Appropriations, implements the Anti-Deficiency Act within the Air Force). Violations of the Act are serious, and can result in formal disciplinary action and criminal penalties.

Lt Col Price is Director of Program Control for the Satellite and Launch Control System Program Office, Space Missile Systems Center, Los Angeles AFB, Calif.

Basic Rules

When Congress provides public funds to a federal agency, it also imposes specific limitation on the use of those funds. These restrictions give appropriated funds their color. Color of money is distinguished by purpose, time and amount. The three rules that state the legal requirements are:

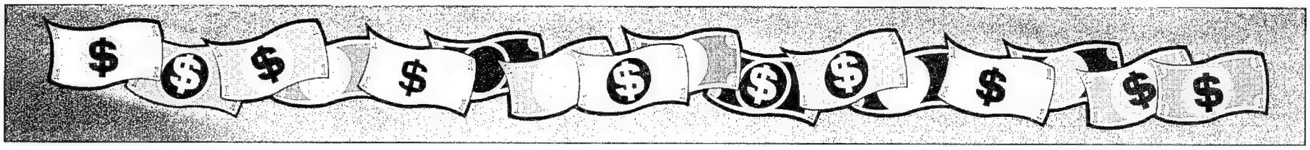
— Propriety of Funding
— Bona Fide Need
— Anti-Deficiency.

Propriety of funding relates to purpose. This rule requires that public funds be used only for the specific purposes the Congress intended. Title 31, U.S.C., section 628, states: "except as otherwise provided for by law, sums are appropriated for the various branches of expenditure in the public service shall be applied solely to the objects for which they are respectively made and for no other." For example, the use of a Navy appropriation to buy tanks would violate the propriety of funding rule unless the Congress had specifically directed the Navy to use its funds for tank procurement.

The bona fide need rule defines the time restriction. It says that all requirement must be funded with an appropriation enacted for obligation in the fiscal year in which the requirement occurs. This means that appropriated funds can only be obligated for legitimate (i.e., bona fide) needs of the fiscal year for which the appropriation was made. Therefore, using funds appropriated for FY 1994 operations to pay for travel that occurred in FY 1993 is a violation of the bona fide need rule.

The anti-deficiency restriction limits the amount available for expenditure. The Anti-Deficiency Act states that the amount appropriated by Congress for any specific purpose and period may not be exceeded. A funding deficiency occurs when the agency obligations exceed the amount Congress appropriated. This rule is straightforward — if you spend more money than Congress allowed for a job, you have committed an anti-deficiency violation.

Before performing any government work, an agency first must have appropriate and sufficient budget authority (BA). To be used legally, the BA must be from the right congressional appropriation (i.e., propriety of funding). The correct fiscal year must be cited (i.e., bona fide need rule). And, the BA must be sufficient to



cover the obligation (i.e., anti-deficiency compliance). If any of these conditions are not met, a violation of public law has occurred.

Creative Financing

The specific rules for each appropriation are different. In fact, in the acquisition area, they often vary down to the line-item level. As a result, the RDT&E (Research, Development, Test and Evaluation) Descriptive Summary and P-Series documents submitted to Congress for individual development and procurement programs make a difference on what can and cannot be done with funds from a given appropriated line item. Your program control office will know the basic rules. However, it is a complex business, and there are always "gray areas."

Acquisition managers who try to stretch the gray areas with "creative financing" are asking for serious trouble. Often the justification for a creative financing scheme is that no regulation specially prohibits the proposed action. While it is true that existing regulations do not provide an all-inclusive list of prohibited actions for each appropriation and line item, the challenge is to find a cite within a budget regulation or congressional documentation that says your proposed action is appropriate. Saying that the regulation does not prohibit an action may provide some short-term comfort; but, in the long term, it provides absolutely no protection from the penalties that arise from a violation of the law.

Here are some basic rules to help avoid creative financing problems. First, it is inappropriate to use funds from a specific fiscal year solely because "the funds are going to expire" or because "they are the only kind of funds available." Neither of these reasons meet the bona fide need rule. Other creative financing ideas almost certain to violate the propriety of funding rule when using most types of acquisition money include the purchase of office plants, janitorial services, flags, facility projects, mail-sorting machines, garden mulch, landscaping services, and baseball uniforms. These are all "real world" examples handled by the comptroller at a single Air Force acquisition center during the past few years. Each came to the attention of the comptroller, either as a question (e.g., "Can we use RDT&E money for a landscaping contract to improve the area around our building?") or as an actual purchase request (as in the case of the sports uniforms). Fortunately, none of these creative financing ideas were ever carried out, but they all had the potential to end careers.

Acquisition managers who try to stretch the gray areas with "creative financing" are asking for serious trouble.

Here are more details on two of the examples. In the case of the landscaping contract, RDT&E funds are inappropriate (except at some laboratory facilities) unless the program office can cite specific words in the RDT&E Descriptive Summary or another official program document provided to Congress, that says "...these development program funds will also be used for landscaping...." (or something to that effect). Since the installation civil engineer (CE) has operations and maintenance (O&M) money which is an appropriate source of funds for such contracts, the solution is to contact the CE office, and make them aware of the landscaping requirement. This does not guarantee that the landscaping project will be funded; however, it does ensure the requirement will be given appropriate consideration by the local commander. And, if/when the landscaping is done, it will be paid for with the appropriate funds (i.e., O&M).

Sports uniforms are also an inappropriate use of acquisition funds, unless the program office can cite a specific statement in its congressional documentation that a reasonable man would consider notification to Congress that funds appropriated for that program will be used to purchase sports uniforms. Program funds can be used only if such a statement exists. However, even if this was legal, it would still have trouble passing the "*Washington Post* Test" (i.e., How would your boss or his/her boss react if he/she read about this in the *Washington Post*?).

Good acquisition managers strive to satisfy their customers. This is not easy in an environment of decreasing resources. It takes strong leadership to get things done. However, bosses who tell their people, "I don't care how you pay for this, JUST GET IT!," are sending the wrong message to their people. To avoid the serious legal trouble that results from misappropriation of public funds, you must deliver the right message. You must insist that everyone in your organization follows funding rules to the letter. When a tough call comes along, contact your local comptroller for guid-

ance. The comptroller community usually can help you find an appropriate way to do the job. Remember, the "number one" customer of everyone in government service is the American people. We spend their money, and their representatives in Congress make the rules.

Summary

"Color of Money" is a useful term that allows people to refer to a complex set of financial rules with a simple phrase. The Anti-Deficiency Act provides the legal foundation for the obligation and expenditure of public funds. Purpose, time and amount are the three elements that give appropriated funds their color. The basic funding rules that cover these three areas are "propriety of funding" (purpose), "bona fide need" (timing), and "anti-deficiency" (amount). All three rules must be met in order to avoid violations of the law. Unfortunately, the details of public finance are complex. As a result, many "gray areas" exist. Trying to stretch the gray areas with "creative financing" can result in serious legal trouble. The best way to avoid misappropriation of funds is to follow funding rules to the letter, and work closely with the comptroller community. The bottom line for acquisition managers — the color of money is important!

...bosses who tell their people, "I don't care how you pay for this, JUST GET IT!," are sending the wrong message to their people.

FROM OUR READERS

LETTER TO THE EDITOR

I found the article on the Software Acquisition Management Maturity Model (SAM3), in the July-August 1994 issue of *Program Manager*, to be interesting and informative. In this regard, I wish to add the following observations.

In December 1993, the Advanced Research Projects Agency (ARPA) Joint Advisory Council chartered a project to develop a Software Acquisition Maturity Model (SAMM). This project, which has wide government and industry participation, is being coordinated by the Software Engineering Institute, and FFRDC at Carnegie Mellon University. The SAMM project office did extensive research on existing work on this topic, and compiled the best ideas, including those in the Navy model described in the article. The SAMM office completed a feasibility study which showed overwhelmingly that the military services, other federal agencies and industry want and need this kind of model. The SAMM project office also established a steering group (chaired by LTG Peter Kind, USA (Ret) and of which I am a member) and a small, but very knowledgeable working group. Both of these groups are hard at work on completing a fully implementable SAMM.

This is an exciting project with far-reaching implications for us at the Defense Systems Management College (DSMC), and we are looking for some help. We need reviewers who are willing to commit from four to six hours per month in reviewing and commenting on our draft documents of a near real-time basis. If you have experience in managing software intensive programs, and are interested in being a reviewer, please send a resume to: LTG Peter Kind, USA (Ret), Software Engineering Institute, 801 N. Randolph Street, Arlington, VA 22203. If you are unable to commit to being a reviewer, we are also looking for correspondents who will receive the drafts and may provide input prior to final publication.

We are working on a very aggressive schedule and expect to have a pilot usage plan finished by May 1995, with a pilot implementation beginning in June 1995.

Lyn Dellinger
Professor of Acquisition Management
Research, Consulting and Information Division, DSMC
(703) 805-2525

DTIC AND THE INTERNET SATISFYING THE NEED FOR INFORMATION

Patricia A. Tillery

In our highly competitive world, having access to, and receiving, timely and accurate information is vital. The Defense Technical Information Center (DTIC) can help you meet these challenges.

The DTIC is the central point within the Department of Defense (DoD) for acquiring, storing, retrieving and disseminating scientific, technical and engineering information. We play an important role in managing information for the DoD user community, which consists of U.S. government organizations, their contractors and potential contractors.

The DTIC is the central point within the Department of Defense (DoD) for acquiring, storing, retrieving and disseminating scientific, technical and engineering information.

The Internet is the superhighway of computer interconnection that provides communication and resource-sharing capabilities to all information professionals. It provides communication links across the street or across the world. You can access information such as messages, documents, databases, technical bulletins, news flashes and stock prices.

Recent efforts to provide information via the Internet are as follows:

Mosaic

The DTIC has been very busy exploring new information frontiers on the Internet. One of our efforts in this area has been on the WorldWide Web (WWW), one of the fastest growing and most popular Internet information systems.

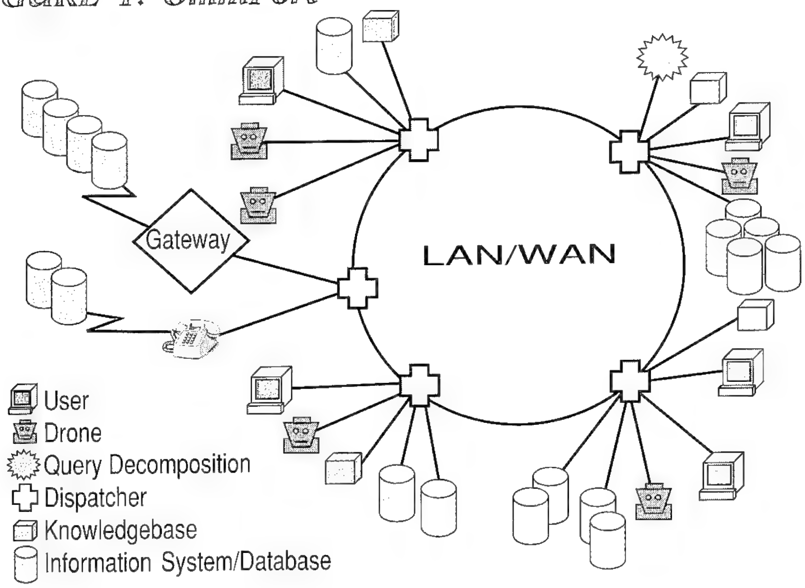
The WWW operates in a client/server environment and provides access to information through hypertext links. Information providers use a Web server to make electronic documents available to users and to point to Internet resources. These documents can contain links to other Web sites, as well as ftp, telnet, gopher and WAIS sites, creating a virtual web of networked information.

The National Center for Supercomputing Applications (NCSA) has developed a client application to be used with Web servers called Mosaic. Mosaic allows users to point-and-clink hyperlinks in Web documents to traverse the Internet without needing to know specific commands or addresses. Users can access everything from the National Technology Transfer Center, the Naval Research Laboratory, the Army High Performance Computing Research Center, and NavyOnline to various newsgroups and thousands of other sources.

The DTIC has installed a Web server and is testing DTIC information and publications on WWW. We also are constructing pointers to information on WWW of interest to our users. Our draft DTIC Home Page can be found using NCSA Mosaic at: http://www.dtic.dla.mil/

If you are connected to the Internet, you can download NCSA Mosaic at no charge by anonymous FTP at ftp.ncsa.uiuc.edu

FIGURE 1. OmniPort



Otherwise, contact NCSA at NCSA Documentation Orders, 152 Computing Applications Building, 605 East Springfield Avenue, Champaign, IL 61820-5518, (217) 244-4130.

OmniPort

The DTIC recently began a project to improve access to widespread information sources including scientific, technical business, and public administration information for the DoD community. This project, known as OmniPort, will facilitate end-user retrieval of information from disparate networked data sources regardless of format, location or automation environment. The system will integrate existing networked information sources into a virtual information storehouse providing timely, comprehensive and economical use of information. The overall goal of OmniPort is to improve the efficiency and effectiveness of the DoD by providing, at a reasonable cost, timely, accurate and comprehensive access to information that is essential for DoD planning and decision making. See Figure 1.

With a single, easy-to-use interface and point of entry, users will be able to retrieve information without knowing the current location, command language, or other access protocols of the underlying information sources. Concept-based searches are translated by OmniPort into the native search languages of a variety of different data sources. Results are returned ranked according to their relevance to the search.

OmniPort is based on the Minerva system developed by Booz, Allen and Hamilton, Inc., and the OmniPort prototype will employ the NCSA Mosaic Internet client. The DTIC is working with Booz, Allen and Hamilton on phase one of OmniPort, which provides concept-based search capability in a distributed operating environment for the Survivability/Vulnerability Information Analysis Center.

Cooperative Programs for Reinvestment

The DTIC has developed Internet access to the Cooperative Programs for Reinvestment (CPR) information system which provides information on government programs and technology consortia which can assist industry defense conversion and reinvestment efforts. The CPR was created by the Office of the Assistant Secretary of Defense (Economic Security), which maintains the data content of the system, while DTIC has created and maintains the Gopher version of the information. The CPR supports several Clinton Administration objectives by providing free Internet access to a single source of information of vital importance to industries impacted by the defense drawdown. Points of contact are provided to obtain further information and, in the case of government programs, instructions on how to apply/use the services.

The CPR system is designed to help develop a strategy of including several government programs (and possibly establishing a relationship with a consortium as the best way to ensure that defense conversion or reinvestment efforts are successful. This is in contrast to relying on a single government program. In addition, CPR includes related documents and links to other reinvestment sources on the Internet (e.g., Department of Commerce Economic Bulletin Board). Users can also access valuable information such as employment and training opportunities, the *Commerce Business Daily* and the *Federal Register*, Technology Reinvestment Project announcements and Small Business Innovative Research program announcements, research grants, and conference schedules. The CPR is accessible via the Internet using Gopher.

Use the following to connect to CPR:

Gopher to:
gopher.dtic.dla.mil, port 70

Public Access Gopher

The DTIC has been expanding its outreach efforts. One outcome of this effort is the DTIC Public Access Gopher (DPAG) designed to make DoD information available to the public. Included in the DPAG are:

— CPR: Cooperative Programs for Reinvestment
— DoD Information Analysis Centers
— SBIR Program Solicitations (Small Business Innovative Research Program) and SBIR Awards Abstracts
— Federal and University Job Openings
— Technology Transfer
— Federal Information

— The NSF list of U.S. Government Gopher Servers.

Gopher to:
gopher.dtic.dla.mil, port 70

Modeling and Simulation Information System

The Modeling and Simulation Information System (M&SIS) is an online service designed for the modeling and simulation (M&S) community to provide current leading edge information on what is happening in the M&S community. Some of the items featured in the system include a bulletin board containing data on upcoming conferences, symposiums, demonstrations and meetings. Other information that can be obtained include minutes from meetings, technical reports, journals, catalogs of models from the Services, articles, and newsletters from current and past M&S events, a list of subscribers, and who is where in the community.

The M&SIS is a joint project between DTIC and the DoD Modeling and Simulation Office (DMSO). The DTIC has agreed to provide the physical host for M&SIS and is responsible for operational functions and telecommunication services. More than 2,000 users have registered since M&SIS became operational during the summer of 1993.

For information on M&SIS or to become a registered user, please contact Mr. Ken Wimmer at: Modeling and Simulation Information System, ATTN: Administrative Support, 1901 N. Beauregard Street, Suite 510, Alexandria, VA 22311, (703) 379-3770, Fax (703) 379-3778, dmso@dmso.dtic.dla.mil

Electronic News Delivery Systems

The DTIC is currently evaluating electronic news delivery systems such as ClariNews. With these systems, end users can harness the power of their computer to find the news on the subjects they want. Electronic news delivery gives you the news that will be in tomorrow's paper, today!

One of the systems under consideration for widespread dissemination is ClariNews, which comes as a USENET style newsfeed. All news on ClariNet is divided into what is known as "newsgroups." Examples of the newsgroups on ClariNet include: science and technology, economic indicators, government information, corporate news, AP and Reuters wire stories, and local stories from 35 regions of the United States and Canada.

The DTIC is exploring new ways to transmit information daily. For more information about DTIC products and services, contact the Product Management Branch on (703) 274-6434 or DSN 284-6434 or write to DTIC-BCP, Building 5, Cameron Station, Alexandria, VA 22304-6145.

ARQ SUBSCRIPTIONS AVAILABLE THROUGH GPO

The Summer 1994 issue of the *Acquisition Review Quarterly* (*ARQ*) will be mailed to all *Program Manager* subscribers and to approximately 11,000 members of the Acquisition Corps in October. This will be the last mailing to both lists. The U.S. Government Printing Office will begin selling subscriptions with the Fall 1994 issue scheduled to be mailed in late November.

Government employees who have not returned the Business Reply Mail subscription form (last two pages in the *ARQ*) are urged to do so as quickly as possible. A letter request is acceptable. Send to:

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Defense Acquisition University
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For additional *ARQ* information, call Wilbur Jones, Managing Editor, at (703) 805-2525 (DSN 655-2525), or Robert Ball, Editor, at (703) 805-2892/3056; Fax (703) 805-3856 (DSN 655-3856).

THE AUTOMATED TEST PLANNING SYSTEM

An Expert Tool for T&E Oversight

M. Scott Roth

One of the major challenges facing the Department of Defense (DoD) test and evaluation (T&E) community is the rapid turnover of key personnel. This turnover results in a loss of continuity, loss of corporate knowledge, and inadequate transfer of knowledge from experienced testers to junior personnel. This loss of test planning knowledge and experience can result in lower quality, needless duplication, lack of standardization and overall inefficiency in the T&E planning and review process. Other factors that can affect this situation are: limited availability of personnel with appropriate knowledge and experience; insufficient time to thoroughly research historic data; and inadequate time and funds to train personnel.

To address this problem, the Office of the Under Secretary of Defense (Acquisition and Technology)/Director of Test and Evaluation (OUSD(A&T)/DT&E) has supported the development of a knowledge-based expert system as a tool to help overcome this loss of knowledge and experience. By capitalizing on the experience and expertise of veteran test planners, and by supplementing their knowledge with historical data and DoD guidance, a knowledge-based expert system has been developed which guides the experienced and inexperienced user through a consistent and thorough process of review, design and assessment of T&E planning.

Mr. Roth is an Engineer with Science Applications International Corporation, McLean, Va.

The Automated Test Planning System (ATPS) is a set of expert system-based tools developed by Science Applications International Corporation and funded by OUSD(A&T/DT&E as a dedicated, long-term effort for improving the overall quality of T&E planning and reporting. The current ATPS concept envisions four modules:

— Test and Evaluation Master Plan (TEMP) Build
— T&E Program Risk Assessment
— T&E Master Plan Review
— T&E Program Design.

With a graphical user interface common across all modules, ATPS helps reduce the learning curve for less-experienced test planners and reviewers; improves consistency, quality and efficiency in TEMP preparation and review process; provides a structured and systematic approach to T&E program risk assessment; and acts as a corporate repository of associated TEMP and test planning knowledge.

Though the first module TEMP Review was developed as an aid for

FIGURE 1. ATPS System-of-systems Architecture

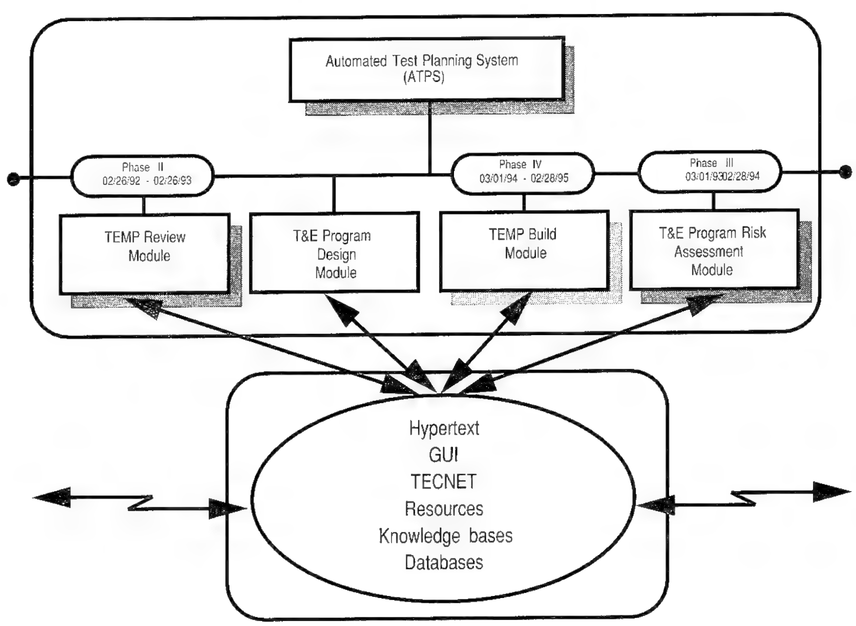
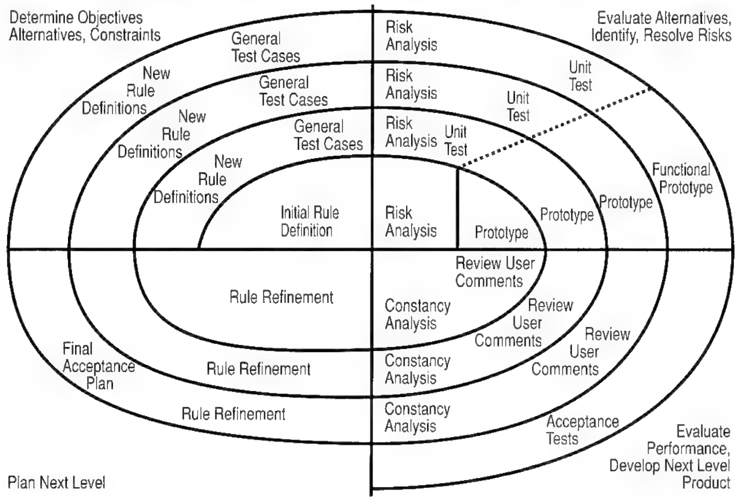


FIGURE 2. ATPS Rapid Prototyping Paradigm



the Office of the Secretary of Defense (OSD) action officers, ATPS has broadened its scope with the T&E Program Risk Assessment Module and the TEMP Build Module and is now well-suited for use by Service and component-level action officers and program managers (PMs). The Services have found that using ATPS to review their own TEMPs prior to submittal to OSD often results in a smoother OSD review.

Development Overview

The ATPS has been developed in incremental phases with each phase building upon the success of the previous phases. The goal of the system is to provide the government with an intelligent, automated tool to leverage the action officer's time spent in the T&E planning and review process.

All ATPS development is guided by a Senior Advisory Group consisting of senior OSD and Service officials. These senior officials guide each phase of development as well as recommend members for the ATPS Working Group. The Working Group develops the system's rule bases, specifies the system's interface requirements, and functions as a configuration control board.

Phase I of development resulted in a system-of-systems architecture (Figure 1) and a detailed system description. This system-of-systems architecture allows for expansion beyond the envisioned four modules. Phase II resulted in the TEMP Review Module as a functioning prototype and proof-of-concept for the architecture and proved that expert systems had a role to play in the test and evaluation oversight arena. Phase III continued implementing the architecture and resulted in the Test and Evaluation Program Risk Assessment Module (TEPRAM) and porting the TEMP Review Module to the Macintosh environment.

Phase IV currently is concentrating on developing the TEMP Build Module which will assist TEMP writers in developing a TEMP by providing the necessary structure in Service-specific language, on-line 5000-series documents, and Service-specific guidance. Phase IV also will include porting the TEPRAM to the Macintosh environment.

The ATPS uses a rapid prototyping development paradigm which has been tailored for the unique requirements of a rule-bases system. The development model resembles a spiral (Figure 2) with the goal of rapidly developing and integrating components of the design for testing, while incrementally building the system to the final product (i.e., the interface development and rule development began simultaneously and continue to parallel throughout development).

A development increment consists of the implementation of new code, integration of that code into the existing design, testing (ATPS uses regression-set testing for the rule base), peer and user review, and the specification of design changes, if required. This incremental approach has several benefits: it demonstrates the evolutionary nature of rule-base development and allows for the addition of new rules as the system matures; it requires testing at every increment, which aids in detecting errors and identifying risk early in the development process when it is easier and less expensive to implement corrections; and it brings users closer to the development process, since they are directly involved in using and testing the product at every increment.

FIGURE 3. ATPS Modular Architecture

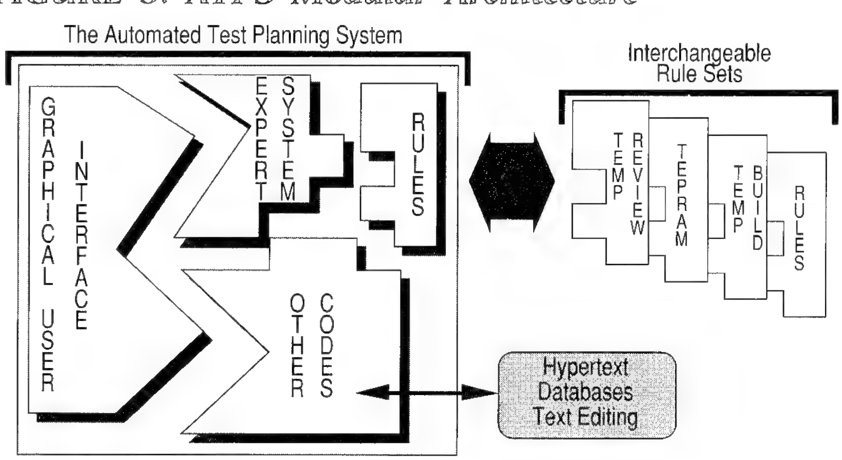
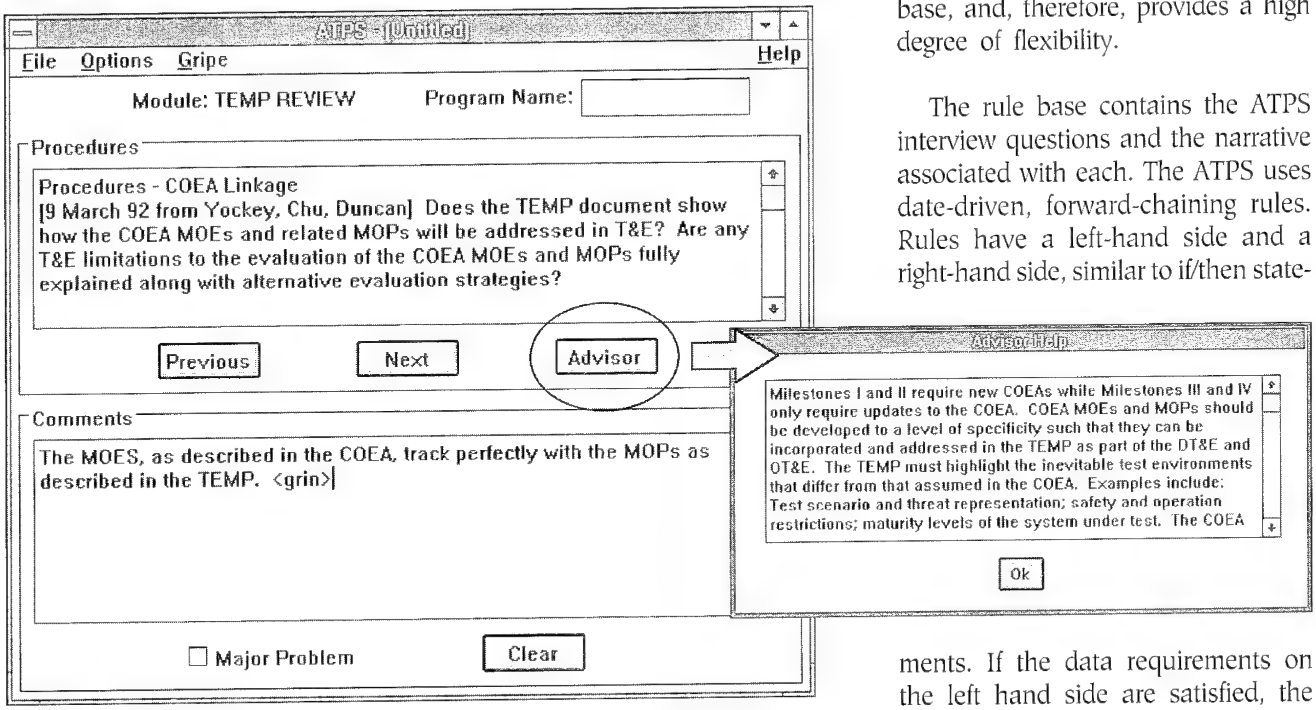


FIGURE 4. ATPS TEMP Review Module with Advisor



System Overview

The ATPS was developed in a manner consistent with modular, Microsoft Windows and Macintosh programming practices with an architecture that accommodates future system expansion.

At a micro level, the ATPS is a fusion of several highly effective technologies: graphical user interface, expert systems, object-oriented C, and hypertext (Figure 3). The beauty of the ATPS architecture lies in its flexibility. For instance, should OSD, or anyone else, wish to develop a new module, the bulk of development would be the rule base; all other components would only require tweaking to enable them to recognize the new rule base. The system really does work as the picture indicates; rules are "swapped" in and out of an otherwise static architecture.

An expert system attempts to mimic the manner in which humans perform given tasks. In general, humans use rules-of-thumb or follow a particular line of reasoning to solve a problem. In the case of ATPS, a user considers key questions or issues and follows a particular outline when tasked to review a TEMP, build a TEMP or provide a risk assessment. The ATPS expert system captures the knowledge (rules of thumb) from senior-level OSD and Service action officers, as well as other sources, and makes this knowledge available to all users.

The expert system has three parts: the inference engine, the rule base and the fact base. The inference engine provides the strategy for conflict resolution among the rules and determines which rule to fire (execute). The ATPS uses the rule-extended algorithmic language (RAL) expert system inference engine which incorporates a proprietary Rete algorithm for conflict resolution. The algorithm evaluates the most recent data in memory (facts) and selects the first rule that is satisfied by the data. The expert system accomplishes this by evaluating all rule data requirements simultaneously.

In the event that certain rules need to be examined first, priorities are applied, giving more important rules a higher priority. In this design, the inference engine is completely independent of the rule base and fact base, and, therefore, provides a high degree of flexibility.

The rule base contains the ATPS interview questions and the narrative associated with each. The ATPS uses date-driven, forward-chaining rules. Rules have a left-hand side and a right-hand side, similar to if/then statements. If the data requirements on the left hand side are satisfied, the right-hand side statement is executed. Since the power of the expert system lies, in part, in its ability to examine an unordered set of rules and determine some order of execution based upon its conflict-resolution strategy, the only structure imposed on the rule bases, where applicable, was that as defined in the DoD 5000.2M.

Rules differ from if/then statements in that order is unimportant; the inference engine determines the firing order of the rules. therefore, to add, delete or modify a rule is a simple procedure; simply append the new rule to the end of the rule base. Conversely, to add, delete or modify an if/then statement, one must always be conscious of the impact on the logic structure.

The data known to be true make up the fact base. The fact base is dynamic, meaning that some facts are asserted before rules are fired (ACAT, Milestone, etc.) and others are derived from and asserted after rules are fired.

ATPS Functional Overview

The ATPS provides the user with a familiar Windows (or Macintosh) in-

terface of buttons and menus to interact with its specialized rule bases, hypertext, advisor, editor and file services.

Core Functions

The ATPS allows the user to save a session and restart it at a later time. Saving a session saves the current state of the rule base and fact base so that a user may resume a session at the exact location in the checklist at which they quit. Other services provided by core ATPS functions include: the ability to save comments entered by the user to an ASCII file; the ability to cut, copy and paste from the editor; the ability to change session information (part of the fact base) and the ability to choose or check parts of the checklist.

The ATPS includes an expansive help system which includes several on-line documents; i.e., DoD Directive 5000.1, DoD Instruction 5000.2 and DoD 5000.2-M, and expert advice. The advice, accessed through the [Advisor] button (Figure 4), has been collected from experienced OSD and Service action officers participating in the ATPS Working Group and from users throughout OSD and the Services. The ATPS also provides its own user's manual online, information concerning how to obtain technical support for the software, and a glossary of T&E-related terms.

TEMP Review Module (TRM)

The TRM (Figure 4) was the first ATPS module completed for DT&E. The primary goals of the module were to provide more consistency to the TEMP review process; to remove personalities from the process; and to reduce training time for OSD TEMP reviewers. The primary knowledge sources for the module's rule base were: DT&E and DOT&E action officers, existing DT&E and OT&E paper checklists and guidance, and the DoD 5000 series of documents.

A typical ATPS TEMP review session has a reviewer sitting at a computer with a hard copy of the TEMP while using ATPS. By cross-referencing the TEMP, the on-line DoD 5000 series, the Advisor and any other supporting documents, the user types responses to the interview questions in the Comments Editor. After reviewing the entire TEMP, the user can save their comments to an ASCII file, import it into a word processor and format it, as necessary. The TRM output consists of each interview question and the user comments, ordered by part as defined in the DoD 5000.2-M, Part 7.

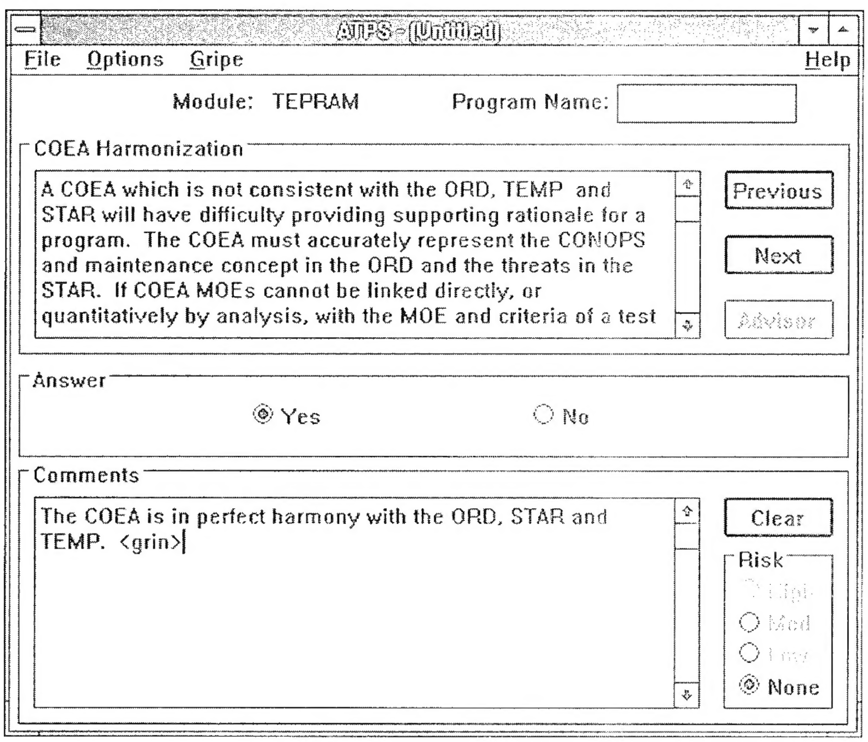
T&E Program Risk Assessment Module (TEPRAM)

The TEPRAM (Figure 5) was the second ATPS module completed. The primary goals of this module were to harmonize key acquisition documents; to assess T&E program risk; and to provide; the E community earlier involvement in the system acquisition process. This module was more challenging to build than the TRM because no governing DoD guidance exists pertaining to risk assessment methodology or structure.

Risk assessment is performed by action officers on a very subjective and individual basis. A risk assessment usually consists of an action officer deciding if the T&E planning supports the program and if the planning is feasible. These decisions are based upon interpretations of both objective and subjective data. Clearly, a formal structure and process, in which root causes of risk instead of ratings of risk were discussed would contribute significantly to T&E risk assessment. The TEPRAM provides such a structure in a manner similar to that of the TRM.

In addition, problems caused by the lack of harmonization of key acquisition documents (COEA, STAR, TEMP, ORD, et al.) have increasingly been recognized for their serious impact on T&E success. The TEPRAM leads the user through a review of these documents to ensure that key parameters of each are coordinated properly .

FIGURE 5. ATPS T&E Program Risk Assessment Module



The TEPRAM output consists of each interview question followed by user response. The output can be sorted by a risk rating (subjectively assigned by the user) or by order of appearance in the interview.

TEMP Build Module (TBM)

The TBM is a software tool designed to provide assistance to TEMP writers. Service T& E organizations have provided their own perspectives on the TEMP-building process by providing advisory information and Service-specific interview questions for the rule base. The TBM is not intended to produce a completed TEMP as its output; rather, it is intended to provide a framework of key points, guidance, and tools within which a writer can develop a skeleton TEMP. Completion and availability of the TBM is expected in March 1995.

Summary

The ATPS has clearly demonstrated the value and viability of an expert system tool in the T&E oversight arena. Expert systems will never replace the technical knowledge necessary to write or review a TEMP, or to assess risk, but ATPS can improve the speed and quality of these tasks, regardless of user level of experience. The combination of highly effective technologies allows the user to concentrate on the tasks at hand rather than volumes of printed reference material and unfamiliar software.

In addition to proving the viability of expert systems, ATPS has validated the system-of-systems architecture and the ATPS rapid prototyping development paradigm as open-ended and highly flexible.

For more information or copies of the software, contact M. Scott Roth, SAIC, (703) 847-5595; or TECNET (The T&E Community Network); send e-mail to: ATPS-USERS@tecnet1.jcte.jcs.mil. To obtain a TECNET account, contact tecadmin at (301) 862-7501.

THE INDIVIDUAL LEARNING PROGRAM

Supplements the PMC

Sharon Boyd

No standard curriculum could meet all the unique learning needs of such a diverse student body as the Program Management Course (PMC) at the Defense Systems Management College (DSMC). Therefore, approximately 40 hours are set aside on the PMC schedule for student self-directed learning called the Individual Learning Program (ILP). The resources of the College, including a number of elective classes, are available during this time for students to learn whatever they need that is beyond the scope of the core curricula.

Students identify areas they believe will be beneficial in their current or future duty assignments, or those which will better prepare them for long-range career goals. Once students determine their needs, each develops individual learning objectives and writes a plan to achieve those objectives during the PMC. With faculty advisor assistance and consolidated reports of previous students' self-directed learning experiences, students identify resources that will help them meet individual learning objectives.

Examples of educational resources available to students during periods set aside for individual needs include the following: interviews with DSMC faculty and other acquisition experts in the Washington, D.C., area; research at the DSMC library and other libraries in the area; computer tutorials, video, and audio tape sessions at the Learning Resource Center; self-arranged visits to program offices in the area; and we offer more than 100 formal "elective" classes, which are scheduled in anticipation of student needs. All PMC students must document at least 40 hours of individual learning effort on their individual learning plan, using any combination of the above.

The ILP has become very popular with the 420 PMC students, not only for the variety of electives we offer but also for the time set aside for them to meet their individual needs, whatever they may be. We have seen the average individual learning hours a student account for an increase from 41 in PMC 91-1 to 67 in PMC 94-1, and the average elective hours students account for an increase from 27 in PMC 91-1 to 40 in PMC 94-1.

In PMC 92-1, the DSMC alumni returned to participate in the elective classes. This has continued, and we now have an average of 35 alumni who return to DSMC for electives. If you are a DSMC alumnus and would like to receive information concerning the electives portion of the ILP, call Lisa Hicks or me at (703) 805-2549.

Sharon Boyd is responsible for the ILP, Program Management Education Division, DSMC.

KEY DSMC PHONE INDEX

Key DSMC telephone numbers:

Office of the Commandant .... (703) 805-3360

Office of the Provost/Deputy Commandant .... (703) 805-2155

Executive Institute .... (703) 805-3054

Faculty Division .... (703) 805-2696

Research, Consulting and Information Division .... (703) 805-2525

Program Management Education Division .... (703)805-5173

Operations and Services Division .... (703) 805-2140

Executive and Short Courses Division .... (703)805-2902

Personnel Services Department .... (703) 805-3363

Office of the Registrar .... (703) 805-2227

DSMC Press .... (703) 805-2892

*NOTE: Defense Systems Network (DSN) prefix is 655 for numbers listed above.
The DSMC FAX number is (703) 805-3185/3857

Eastern Region .... (617)377-3593
DSN: 478-3593
Fax: (617) 377-7090

Southern Region .... (205)876-2730
DSN: 746-2730
Fax: (205) 876-2730

Central Region .... (314) 263-1142
DSN: 693-1142
Fax: (314) 263-1719

Western Region .... (310) 363-1159
DSN: 833-1159
Fax: (310) 363-5992

FROM THE COMMANDANT

The last time I spoke with you, I discussed the changes that were occurring at DSMC — particularly in our courses. I briefly described a process called "DSMC-95," which is being used to develop the new courses based on your inputs. I invite you to review the May-June issue of the *Program Manager* magazine for the details. Mr. Bill Bahnmaier, the DSMC-95 program manager (PM), described the process brilliantly in his article "Keeping Pace With Change." I am happy to report that the process continues on track and is yielding outstanding products and results.

The first product to emerge from DSMC-95 was the PMT 303. The director, Mr. Ted Bloomer, and his team worked an incredibly compressed schedule to bring this course on line this fiscal year. I think they have done a great job. As you may already know, it is a four-week course designed for ACAT I/II PMs/DPMs and PEOs. The target student is one who is en route to one of the mentioned positions. Recently, we graduated our first pilot PMT 303 course, also known as the Executive Program Manager Course (EPMC). The 10 students represented each of the Services. Some students were recently assigned to their positions; some had been in their positions for some time; others were just leaving their positions. We could not have asked for a better mix of student experiences and expertise to attend the EPMC pilot course.

The course duration was four weeks, and because of the extensive homework undertaken by both student and DSMC faculty, we were able to tailor the course to the needs of each student. This resulted in "just-in-time" education for each of the students. Initial and formal feedback from the students indicates we have a course that will be very much in demand. The following are a few of the "bottom-line" comments they had regarding the course:

— A must course for program managers.
— Upper-level management should strongly support this course.
— Best course ever offered by government.

The formal course debriefing given to me by the EPMC class leader was one of the best I have received on any subject. While it pointed out the need for the course and its strengths, very constructive comments also were given. These included:

— Tailor course length to student requirements.
— Shift faculty from "stove pipe" to PM view.
— Tailor guest speakers.

We have already incorporated these and other comments into the next EPMC offering which starts 24 October 1994.

In addition to the EPMC, our newly revised Fundamentals of Systems Acquisition Management (FSAM), also known as ACQ 101, was piloted recently. Ms. Andrea Garcia, director, and her team have done a splendid job developing this new course. I call it a "pilot" pilot because the students were consortium schools instructors who will teach the course. The first pilot with regular students will begin 19 September 1994. The feedback from the "pilot" has been excellent. This new course is "core," which means it is a requirement for most of the acquisition workforce; exceptions are the contract and audit communities.

As I have said before, these are busy and exciting times at DSMC. We are working hard to do our part to continue improving the acquisition workforce. We do that by listening to you, understanding what you need, and developing the highest quality education and training to meet your needs. As we continue keeping pace with the ever-increasing changes in acquisition, I will keep you informed as to how DSMC is doing, both from my perspective and from yours based on your feedback. As always, let us hear from you. Until next time.

— **Brig Gen Claude M. Bolton, Jr., USAF**